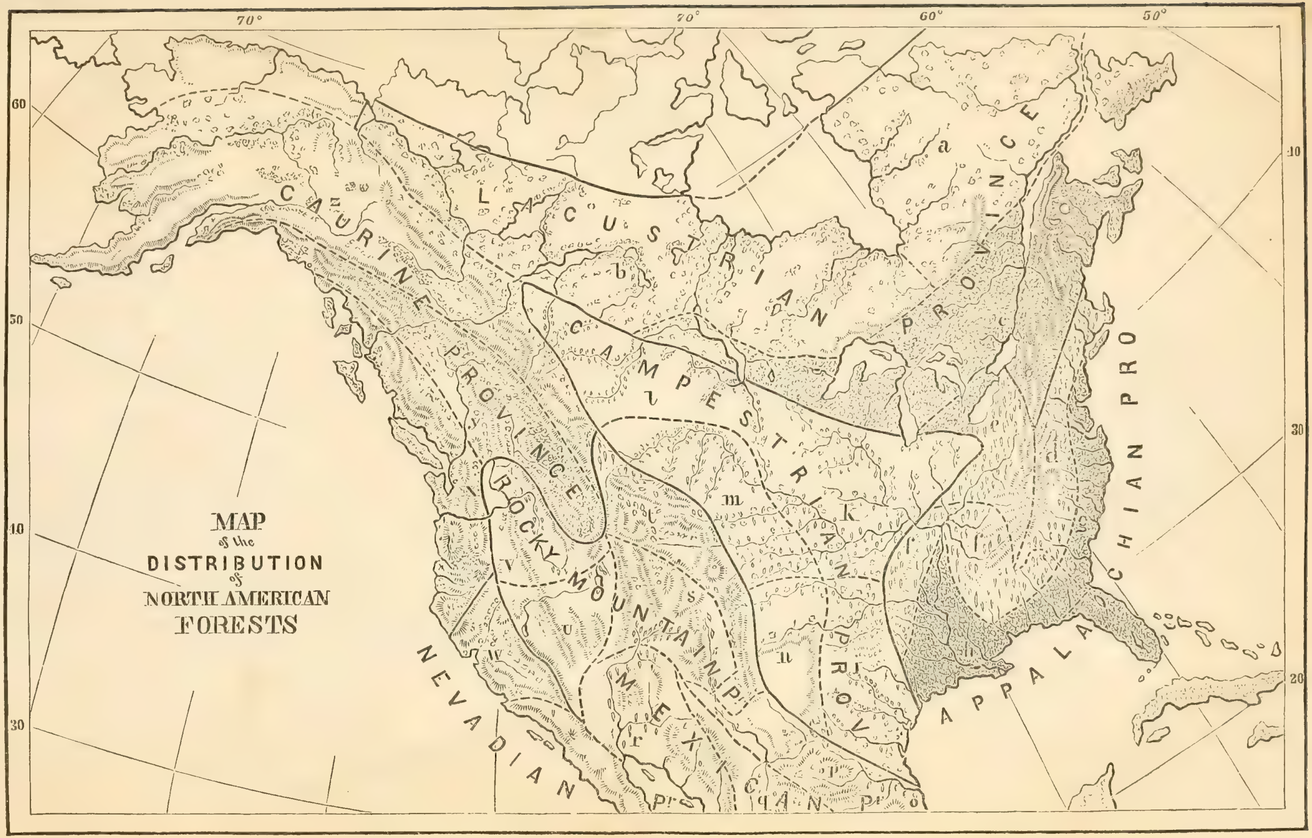
MAP
of the
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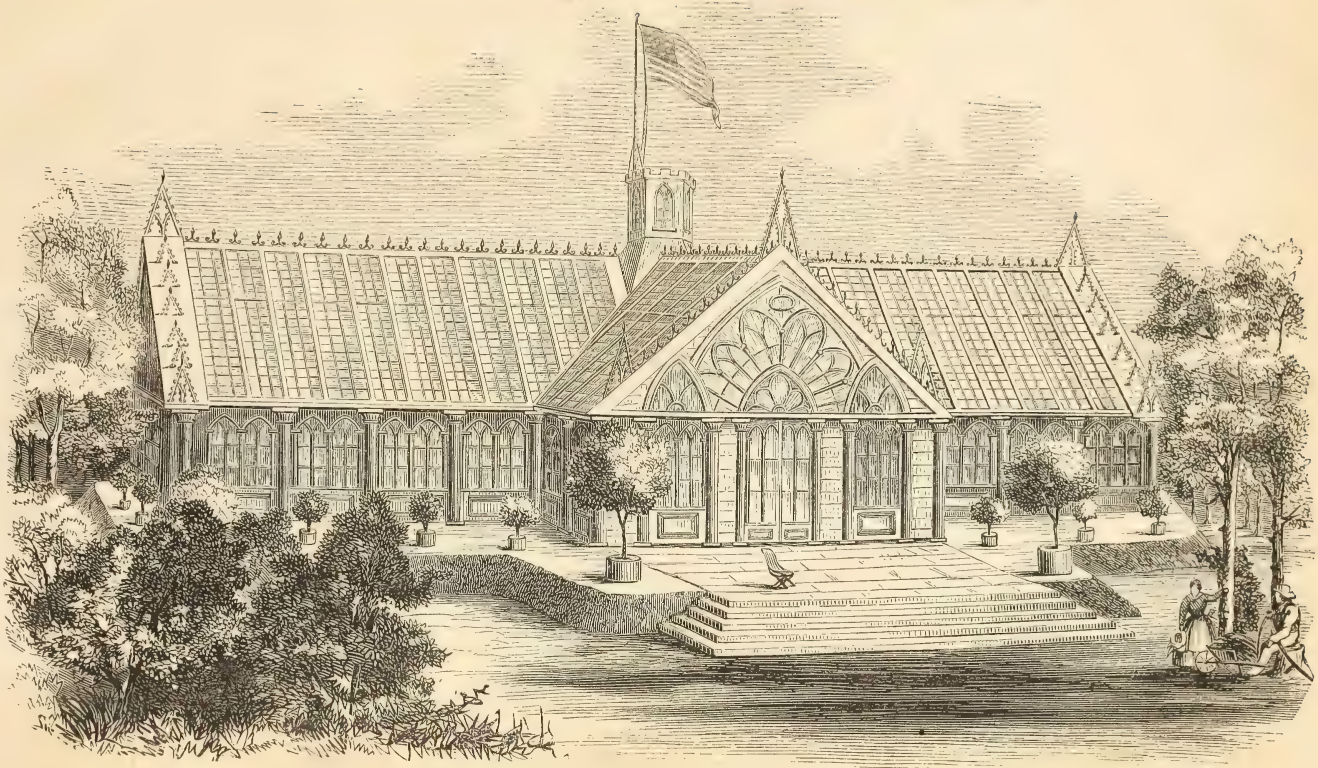

PLATE I.—Grapery, as referred to by Dr. S. J. Parker.

36th Congress, 2d Session. | HOUSE OF REPRESENTATIVES. | Ex. Doc. No. 48.

REPORT

OF THE

COMMISSIONER OF PATENTS

FOR THE YEAR 1860.

AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1861.

In the House of Representatives, *February* 28, 1861.

Resolved, That there be printed for the use of the members of the House of Representatives two hundred thousand extra copies of the Agricultural Patent Office Report for 1860, and fifteen thousand extra copies for official distribution by the Department of the Interior: *Provided,* That said Report be printed in brevier type, and be compressed within four hundred and eighty pages octavo.

55127

REPORT

OF THE

COMMISSIONER OF PATENTS.

UNITED STATES PATENT OFFICE,
January 29, 1861.

SIR: Agreeably to the design of Congress as indicated by the appropriation of June 25, 1860, "For the collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement of cuttings and seeds," I have the honor herewith to transmit the Agricultural portion of my Annual Report.

Very respectfully, your obedient servant,

S. T. SHUGERT,
Acting Commissioner.

HON. WILLIAM PENNINGTON,
Speaker of the House of Representatives of the United States.

PRELIMINARY REMARKS.

The agriculturists of the United States, to whose enlightened judgment these remarks are addressed, will doubtless appreciate the spirit in which they are offered.

The requirements of the present age, and the permanent importance of the subjects embraced in its operations, demand that the powers of this agency of the Government should be enlarged. This opinion was expressed in the views I had the honor to submit to the Secretary of the Interior at the period of my being called by that functionary to the position of Superintendent of Agricultural Affairs.

A vast majority of the intelligent agriculturists of the country, dissatisfied with the limited functions now exercised by the Government, not only confidently anticipate, but demand an organization at least equal in importance to that of any other department.

No object is more worthy of governmental care; nor is there any field of action in which the satisfactory realization of progress in population, wealth and civilization can be so certainly attained.

All civilized nations have in all times fostered agriculture as a primary and indispensable employment of man. This fostering has been direct in the bestowment of bounties; indirect in the restraints imposed upon foreign competition; and educational and providential in the encouragement of industry and ingenuity through the information and facilities which governments alone are capable of providing with efficiency and to a satisfactory extent. The Agricultural Division of the United States Patent Office has been created as the agent of the Government to give effect to its purposes in the last-named and most beneficent manner; and is, to the common mind, the only visible or appreciable agency for the promotion of this great and essential interest.

The degree of encouragement imparted by our Government by means of import duties, the bestowment of public lands upon actual settlers, and the distribution of the Reports of this Office—to say nothing of the influence and aid of local and general agricultural

societies—cannot be estimated. It is, therefore, impracticable to institute a comparison between the benefits conferred by it and those conferred by the governments of other nations upon this branch of industry; yet it may be profitable in this connexion to review briefly the provisions made by several countries of Europe for the promotion of agriculture.

ENGLAND.—There is no special Bureau of Agriculture connected with the British Government; but the statute books are replete with enactments having in view the encouragement of this branch of industry; and the government expenditures therefor are upon a most magnificent scale. A living, active interest in it pervades the whole empire, and finds expression in many forms, giving existence to organized associations, to magazines and journals, to schools of varied grades, and to experimental gardens and farms in many localities. Moreover, the aggregation of wealth in the hands of comparatively few proprietors, and the stability of its tenure, enable them to execute upon enlarged plans many of the enterprises which in other countries, but especially in our own, can only be accomplished through the aid of the General Government.

FRANCE.—The Agricultural Department at Paris is composed of a Director, three Chief Clerks of Bureaus, three Assistant Chief Clerks of Bureaus, and twenty-seven Clerks of various grades, who are under the control of a Minister of Agriculture, Commerce, and Public Works. The three Bureaus are thus divided:

I. *Bureau of Agricultural and Veterinary Instruction.*—The organization of the Imperial Schools of Agriculture is governed by a decree dated October 3, 1848. There are three schools, situated at Grignon, Grandjouan, and La Saulsaie. The instruction is both theoretical and practical, the object being to qualify managers, or overseers. The period of study is three years, and the charge 750 francs, or $150, for board and instruction. The officers, professors, and tutors are appointed by the Minister of Agriculture; the cultivators, or practical instructors, by the Director of the schools. The cultivation is carried on at the expense of the State, which also defrays the expense of instruction.

In the farm schools, of which there are fifty-one, the instruction is only practical. The Director, who is appointed by the Minister, personally controls the school and its field operations. He is allowed an annual sum of 175 francs, or $35, for the support of each pupil.

There are three veterinary schools, situated at Lyons, Alfort, and Toulouse. These establishments were founded by an ordinance of 1825, which, with the exception of some modified articles, constitutes the groundwork of the present organization. Candidates are admitted after a satisfactory examination in the French language, arithmetic, geometry, and geography. They must be at least 17, and not more than 25 years old. The course of study lasts four years, at the expiration of which time those found qualified to practice medicine among domestic animals receive diplomas, for which they pay 100 francs, or $20.

The sheepfolds of Gerrolls and Haut Tingry, and the cowhouses of Tin and St. Agneau, are managed at the expense of the State. Stipends are granted thus: 1. For agricultural colonies, or establishments in which poor children are trained as farm operatives; 2. For lectures on agriculture; 3. For four nurseries in Corsica.

There are six Inspectors and one Assistant Inspector attached to the service of "Inspection of Agriculture."

II. *Bureau of Encouragement to Agriculture and of Relief.*—It is the duty of Prefects to point out to the Administration the agricultural improvements and arrangements required by their respective departments, in which they are assisted by the General Councils, Consulting Chambers, and Societies of Agriculture.

The Minister annually grants subsidies to agricultural associations which have proved their title thereto according to certain forms. Special allowances of from 3,000 to 4,000 francs are made in those departments where the silkworm is cultivated, in order to improve the product. Books are also distributed, with a view to increase agricultural knowledge. Fairs are held under the direction of the Government, and rewards distributed for improvements in the products of the soil, in machinery for agricultural purposes, in the races of animals, and in the skill of farm operatives. The institution of fairs of cattle for slaughter dates from 1844, and of those for reproduction, from 1860. The former are held at Bordeaux, Lille, Lyons, Nantes, and Nismes. That at Poissy is general. The number of regional or district fairs in 1851 was three; in 1860, twelve. They are held at Amiens, Aurillac, Bordeaux, Caen, Colmar, Montpelier, Lons-le-Saulnier, Poictiers, Puy, Vannes, Tarbes, and Troyes. Since 1857, prizes of 5,000 francs and 3,000 francs have been conferred upon agriculturists for examples of excellence. The directors of rail-

roads abate one-half of the ordinary charges in favor of exhibitors. Numerous fairs are held by local societies in emulation of the Government exhibitions. Since 1819 a fund has been raised by an additional levy of one centime on landed, personal, and movable property, in 1860 amounting to an aggregate of $402,200, which is distributed among necessitous persons who have sustained losses by fires, storms, hail, inundations, falls, blows, wounds, &c. An abatement in taxes is also made in favor of such persons.

III. The third Bureau is charged with subjects for legislation relative to subsistence, including the rates of duties on the importation and exportation of grain and flour, and takes cognizance of the prices of grain, the establishment of fairs and cattle markets, regulations in bread-making, slaughter-houses, and the sale of provisions.

SPAIN.—The Minister de Fomento, or the Department for the Promotion of the Public Welfare, controls the internal improvements, including roads, canals, harbors, schools of engineering and agriculture, forest culture and mining, the abolition of feudal incumbrances, the rectification of boundary lines, meadows and pastures, the formation of new communities, colonization, weights and measures, commerce and industry, and agricultural and industrial societies. The personnel of this Department consists of the Assistant Secretary of State, two Directors General, and thirteen officers, Chief of Engineers, and officers of the Treasury and Archives. There is also a Royal Council of Agriculture, Industry, and Commerce, with a president, five vice-presidents, secretaries, and twenty-one members for agricultural affairs, ten for industrial affairs, and thirteen for commercial affairs. The Royal Commissioners for the superintendence of agriculture in the provinces form a junta of twenty-four members; and there are juntas in the provinces for the same purpose presided over by the respective provincial governors. The studs are under the control of a Director General and an Inspector General, with the appropriate officers, in the respective cities.

The association of herd-owners consists of a permanent central committee of thirteen members and four officers. The Queen presides. There are nine agents conducting the business, while a number of principal collectors of revenue are stationed in those provinces in which the Cabaña Española (Spanish Breeding Merino Flocks) have their pasture grounds, or through which the flocks are passing. The agents in charge of irrigation and aqueducts (elsewhere minutely

described in this Report) are under the control of Directors. Economical societies, under the auspices of this Department, contribute by correspondence, publications, exhibitions and premiums to the promotion of agriculture, cattle raising and rural industry.

BELGIUM.—The Government intervenes in agricultural affairs both directly and in the manner of counsel and encouragement. In every province there is a provincial commission, which is an emanation from the independent agricultural societies pervading the kingdom. There is, moreover, a Superior Council of Agriculture, which the Government consults upon subjects of importance. This council is composed principally of delegates from the provincial councils.

The independent or primary agricultural societies receive subsidies from the Government. They organize exhibitions for competition, and seek, by every means, to promote agricultural progress. There are agricultural and horticultural schools, a veterinary school, and a depot of stallions belonging to the state. There is, also, a veterinary service which gives attention to the sanitary police of domestic animals. The Government assists in introducing breeders of approved races for perfecting the domestic breeds, and enforces rules to prevent the employment of inferior stallions. It also circulates choice works on agriculture, introduces improved implements and new machines, and seeds of forage and other plants, and directs attention and presents inducements for clearing uncultivated lands. It has agencies, also, to promote irrigation, forest culture, and the cultivation of "*bruyères*," or waste land, and who supervise the works executed by the communes, to which subsidies are granted to encourage the planting of trees upon their lands. There are agents, or supervisors, of parish roads, also, which it is desirable to preserve and improve.

AUSTRIA.—Prior to the year 1853 there was in Austria a special Department of Rural Economy and Mining; but it has been abolished, and all matters relative to rural economy, forest culture, colonization, societies for the promotion of agriculture and forest culture, and agricultural instructions have been transferred to the Department of the Interior, the affairs of which are conducted by the Presidential Board, and two sections of twenty divisions, each section having a chief and the divisions being directed by counsellors of the Ministry.

RUSSIA.—The patronage of agriculture by the Government is very ample, but conferred in forms so varied as to render an estimate thereof impracticable. The subject is committed to the Minister of

Domains, to whom all information is communicated by the several governors, directors of crown lands, inspectors of agriculture, and agents in different parts of the empire, commissions for regulating the classes of peasants, corresponding members of the Scientific Committee of the Department of Rural Economy, and societies for the advancement of agricultural science. The information obtained from these and other sources is digested and published under the authority of the Department of Rural Economy.

PRUSSIA.—There is in Prussia a Department of Agriculture, with a Minister, assisted by five chief officers and numerous clerks detailed at his discretion. Under this Department is the Rural Board of Agriculture, whose duty it is to recommend and apply measures for the gradual abolition of certain feudal rights over the soil, which form serious obstacles to the development of the agricultural resources of the country; and to take cognizance of all projects in relation to the tariff; the division of land held jointly and the adjustment of litigations arising therefrom; rights of possession; the administration of the laws concerning the preservation of forests, fields, game, fish, and riparian rights; the regulation of drainage and the construction of dikes; the state studs; the formation and superintendence of institutions for agricultural education; the control of agricultural societies; and the general encouragement of agriculture and rural economy.

This Board is composed of a President appointed by the Minister of Agriculture, and taken, when possible, from among the Council of his Ministry; a Secretary General, likewise residing at Berlin, Counsellors of Ministries, whose duties embrace certain agricultural and industrial affairs; scientific men, learned in national economy including statistics, in technology and natural history; practical agriculturists and other gentlemen residing in the provinces, who act as correspondents of the Board, and may be called together to advise in its deliberations. Other gentlemen, adepts and experts, are also called upon when necessary, to submit their views in writing, or otherwise, upon subjects of paramount importance. These may be called the ordinary members, while the respective Presidents of the Central Agricultural Associations may be termed the special or extraordinary members of the Board.

The Secretary General has charge of the record, and conducts the correspondence. He has charge, also, of the Technical Central Bureau, and of the museum of collections. He also compiles information

from all accessible sources, and is the editor of the Annals of Agriculture.

The Board makes an annual report to the Minister on the condition of agriculture, with an expression of its views thereon.

United States of America.—The Agricultural Division of the Patent Office comprises as its personnel a superintendent; four clerks, including translators and writers; and a curator or gardener, and assistants; and its average annual expense for the last three years has been about $53,000, including the distribution of plants.

I should be wanting in fidelity to the trust reposed in me were I not earnestly to urge a more efficient encouragement to this great basis of all prosperity. The enlarged organization I have proposed is indispensable to the prosperity of our country; and the consummation of such a creation is an achievement in which man may well be proud to engage.

That the great interest of agriculture should be without suitable representation in the Government appears as an anomaly, and indicates a want of appreciation of the true state of our civilization. The present embryotic organization owes its existence to ideas of expediency expressed in the form of an annual grant to collect and distribute seeds and cuttings and information on their culture. That it should prove inefficient for the accomplishment of great and far-seeing enterprises is necessarily incident to its limited foundation and unstable tenure. The remedy is with the American people and their legislators; and it is confidently believed that, as the members of the great producing family become imbued with these truths, they will manifest their opinions by firm and vigorous action. An adequate organization and corresponding appropriations will be greeted throughout the land with the approving response of millions. A Department established under such auspices for the benefit of the paramount agricultural interest of the country should be separate and apart from all influences other than those prompted by the highest regard for the public good, unobtrusive in its conduct as in its nature, and having truth for its object. It should endure untrammelled, and free from all partisan considerations. It should know no section, no latitude, no longitude. It should be subservient to no party other than the great party of production.

In the early stages of the formation of this Government it was not

to be expected that a Department of Agriculture would be established. In the records of the colonial history of this nation, there are indications that something was done for the encouragement of this pursuit. As the necessity more and more pressed upon the people, sheep, as well as the fruits of the earth, were guarded from their natural enemies by premiums or bounties for the destruction of the depredators, and numerous intimations were given by way of recommendation calling the attention of farmers to their own interests, intimately associated as these were with the public welfare. The pressure of emergencies during the Revolution was not friendly to the prosecution of measures encouraging to agriculture, although most of the great leaders were cultivators of the soil. Population was then sparse, and the wants of men were easily supplied from their wide acres on the fertile domains of a virgin continent. The necessities of the new Government, too, were those produced by war and revolutionary events, and had to be met at once. Hence the appointment of Secretaries of War, of the Navy, and of the Treasury. For our Foreign relations, a Secretary of State was then needed; and, as other wants became imperative, with the return of peace and the increase of population, a Postmaster General, and new Departments with their Bureaus, a Secretary of the Interior, an Attorney General, a Commissioner of Lands, of Pensions, of Indian Affairs, of Patents, of Customs, and of Public Buildings were called into existence.

Gradually, as the country advanced, and the vast forest fell before the axe of the hardy pioneer, and the broad prairies felt the hand of the immigrant scattering abroad the seed-corn and grain borne further and further from the East to the West, a new spirit of agricultural enterprise started into life; and societies have hence sprung into existence all over the land. Great credit is due to these, and to many an intelligent farmer and planter for their zeal and practical adaptations to secure and extend a higher state of culture, as well as to the periodicals and public journals wholly or partially devoted to this subject and to those arts and sciences intimately connected with its progress and improvement.

The public desires have been naturally directed to the General Government for its fostering aid and such encouragement as it may rightfully give. With its wide domain, its resources of information far and near, and its ability to present to the people accurate knowledge of the best productions of foreign culture, the agriculturists of

the country have everywhere felt that they had a claim upon it for all that might be done to promote the efficiency both of associated effort and of personal or individual enterprise.

From this conviction the Agricultural Division of the Patent Office has arisen. At first, a mere clerkship charged with the duty of gathering agricultural statistics and having them printed in the report of the Commissioner of Patents, with various statements of the condition of agriculture, together with the disbursement of a trifling appropriation for the distribution of seeds, it has increased with the demands of the agricultural people to the large proportions of a Bureau. Its Report in 1842, consisting of less than 20 pages, and embraced in the same volume with the Report on Mechanics, has been gradually enlarged, and now forms a separate volume of useful and scientific matter. The distribution of seeds, though in some instances influentially opposed because misunderstood, has grown in favor with intelligent and patriotic agriculturists, and the demand for plants and seeds introduced from foreign countries has become general and urgent, and their propagation has already conferred incalculable benefits upon the country.

These operations are a necessity of the time. They form the connecting link between the hitherto forgotten farmer and the Government. Through the commerce of the country, they are to aid the great interest of agriculture by the purchase and introduction of new varieties of seeds from other countries, and the interchange of those native to it, but neglected, and hence requiring renewal in our climate. Information from every available source, at home and abroad, is collected, and disseminated, as the seeds are, gratuitously. The farmer and the planter are thus encouraged in their experiments, while this Division becomes a means of communication with the governments and peoples of all lands, providing what may be suitable for their soils and climates, strengthening our friendly relations with them, and at the same time using its official power and influence to obtain whatever may advance the agricultural interest of our own country.

At the time when our Government was organized, the art of agriculture was mere empiricism. The natural laws by which a successful practice is governed were not known: for the nature of substances, their true history, and the part they perform in producing and sustaining life, were unknown. It is only within the last quarter of a century

that science has vindicated its true position. Without it there is no help for agriculture. All history teaches us that sterility and depopulation, and changes of locality by civilization, are the consequences of governmental neglect to sustain this great branch of industry. At the present period no man can hold himself guiltless who ignores its importance or withholds that fostering aid without which a disappearance of population must surely ensue; and such governmental improvidence and neglect of individuals must lead to wretchedness and death. No nation can prosper without progression in this branch of industry.

It is the duty of the Government to care for its domain—the joint property of the people, and the nation's hope.

All our vast domain is indeed far from being capable of cultivation; but there are means in science, if properly invoked, by which millions of acres that, remaining under their present condition, will forever be unoccupied, might be brought to a state of fertility. Our swamps, now fruitful only of disease, might be made to perform the most important of duties. Our uplands are being rapidly exhausted and abandoned to further waste. We cannot calculate our loss in worn out lands, but if we would form a faint conception of its immensity, let us make an effort to estimate the amount of money that would be required to put each acre in the condition of fertility in which it was when first occupied. But the day is not far distant when thousands of square miles of uplands will cease to be cultivated, and when the population of vast regions will be restricted to the alluvial and the marl formations.

In the North and in the South the soils have been wearing out through the reckless nature of our system of cultivation, and the cry now is, What shall we do to meet this difficulty? Agricultural societies, associations, clubs, and libraries, are everywhere organized; and agriculturists generally, though conscious how much good has been done by the efforts put forth, are yet aware how insufficient in some respects their unaided work is, and turn to the Government for the might of its countenance and coöperation. Wanting aggregated capital and the science which capital can command, they justly demand this coöperation of the Government as a right.

A glance at the various duties thus far embraced and performed in the agricultural agency intrusted to my care may help to form a better judgment of what further development it admits for increased

usefulness by the enlargement of its means. With the moderate appropriations heretofore made, it is admitted that vast benefit has already resulted to the country from its operations. Taking these results as the means of estimating what a more liberal patronage by the National Legislature, such as lies within its province to confer, might have accomplished, it may well be doubted that any method of furthering the public welfare promises better to reward the earnest attention of those who have it in their power, if they feel it to be their duty, to promote an interest on which so largely depends the means of sustenance and comfort of our people for generations to come.

The distribution of seeds of ordinary character is not alleged to be necessarily an object of governmental duty ; yet, so far as heretofore practiced, it has been attended with undoubted good. New varieties of vegetables have been introduced; valuable plants not known in the country have been naturalized with decided advantage to the entire community; while the crops of cereals have been vastly improved.

A large proportion of the limited appropriation made by Congress for the fiscal year ending June 30, 1860, for the collection of seeds, was disbursed in the purchase of tea seeds, in the construction of propagating houses for their reception, in the expenses attendant on their distribution, and in the preparation of the annual Agricultural Report. It was therefore impossible to procure seeds and cuttings for general use, as before.

It is believed, however, that the money so expended will prove a judicious investment. Thirty-two thousand healthy plants have been disseminated among gentlemen who had expressed a desire to experiment with them ; and of that amount fully two-thirds were forwarded to planters residing south of Virginia and Kentucky. There will be eight thousand more rooted cuttings for distribution this winter; and it is contemplated to continue their propagation to a large amount each year in order to supply the continued demand, and thus insure a fair trial of the tea plant in our country.

It is confidently hoped that by substituting machinery and steam power for the tedious and laborious Chinese mode of preparation exclusively by hand, tea may be extensively manufactured here, and even become an article of export, especially as the necessary care and labor in the process is better suited to the weakly and young,

who are unfitted for the culture of cotton and tobacco, and the heavier duties of the plantation.

In Assam there is a variety of the tea plant said to be of hardier growth than the usual Chinese, and its leaves bring a higher price in the English market. It may be advisable at an early day to procure a supply of the seed to ascertain their adaptedness to our climate and soil.

The appropriation made by Congress for the fiscal year ending June 30, 1861, will enable the Agricultural Division to extend its operations and usefulness by procuring and propagating various economical, medicinal, and useful plants, which it has been difficult heretofore to introduce with any prospect of success. By judicious changes the propagating houses connected with the garden of this Office have been better adapted to the general purposes in view. The garden, as far as it would admit of it, has been laid out with taste, and when planted with useful and ornamental shrubs and trees will present an attractive appearance. If enlarged and properly located, it may become an ornament to the capital, an object of utility to the country, and of general interest to the world; but the ground at present appropriated to propagation is not suited, either in extent, in position, or in the nature of the soil. Other grounds should be selected for the purpose, for in no other manner can an equal amount of money be so advantageously employed.

The introduction of foreign plants and their acclimation are not more important than that many indigenous plants, now uncultivated, should be subdued and applied to our use. But neither of these projects can be satisfactorily consummated without skill and knowledge. The procurement of valuable foreign plants and cuttings is not unfrequently attended with much trouble and expense; yet their indiscriminate distribution, often among persons not acquainted with the requirements for their successful acclimation, has been, and must continue to be, attended with the loss of time and of money, and with the impairment of the public confidence in enterprises otherwise full of promise and beneficence. Had the recently imported tea seeds been distributed, on their arrival upon this continent, the experiment would have entirely failed, as in former instances, with respect to the cork acorns, for example, wherein, with but few exceptions, the whole distribution was lost, while those planted in the

Propagating Garden, with scarcely an exception, have been developed into vigorous plants. With suitable grounds and houses, and apposite appurtenances, the successful introduction of a single specimen will usually insure any desired number of plants, and the object is thus gained forever. These necessary adjuncts, while advancing the agriculture of the entire country, may also be made economically subservient to supplying all the ornamental trees requisite for the public grounds of the District of Columbia, and of the entire country.

Considering the nature of the duties which should fitly devolve upon this Department, it would seem eminently proper that the administration of these public grounds should be intrusted to its care and attention. It is, indeed, a matter worthy of consideration whether the best interests of the country would not be promoted by bringing all the public lands under the control and immediate supervision of such a Department. There are questions of serious import connected with the management of these lands which may not longer be postponed without sinister and momentous detriment to the future welfare of the country. As is elsewhere intimated in these remarks, the mineral wealth of the nation, so intimately connected with its agricultural prosperity, demands the highest and most intelligent offices of the Government, guided by the lights of science. These great national resources cannot be neglected with impunity; they demand, more than any other portion of the nation's dependencies, other cares than they have received; and this interest could not be placed in better keeping than under a Department of Agriculture of ample capacity and power.

Through our consular and diplomatic agents it is possible to introduce into the United States every ornamental and useful plant, and every animal, bird, and fish, valuable for its special qualities.

A large sum has been applied to the purchase of seeds abroad. The Superintendent was instructed to proceed to Europe to make the necessary selections, to obtain them on the most advantageous terms, to ascertain the safest manner of transporting them to this country, and to procure such information relative to agricultural matters as would be likely to interest and benefit our country.

The seeds, cuttings, &c., so obtained, will be forwarded from their respective localities as soon as they shall be in a condition to bear transportation. Seeds have been procured from Poland, Algiers,

and the borders of the Black sea, where the climates appear adapted to the production of the grains most sought after by our farmers.)

The Department has also given great attention and encouragement to the cultivation of the native grape, and the manufacture of wine therefrom; and there can be no doubt that its exertions have had considerable influence in causing many intelligent persons to engage in this important branch of industry, from the success of which, it is believed, improved physical and mental health, as well as increased wealth to our people, may be expected. It is, indeed, certain that the native grape may be introduced and cultivated with success in those regions which have become exhausted by over-cropping with other objects of culture.

Cuttings of superior native vines have been received from cultivators and amateurs. These will be propagated with care, and will afford interesting opportunities for making experiments in hybridizing with foreign or other unacclimated varieties.

(An assortment of seeds and cuttings collected by Rev. Dr. Barclay in the Holy Land have likewise been received, and a portion of them distributed. The last shipment contained some articles which will be sent to the Southern States in time for their early spring sowing.)

The effort to procure alive a few swarms of the Italian Bee, "Apis Ligustica," has been unsuccessful, owing to inattention to the instructions given by the agent of the Office. It is expected that the loss will be repaired.

Not many years ago the cotton plant was little better than a mere weed. It now vivifies the commerce of the world. The silk worm is an introduction of immense emolument to France. New varieties have been acclimated in that country which feed on the oak, the ailanthus, and the palma christi; and it is expected that their product can be manufactured at prices so low as to bring it into use in making sails for vessels, and for other common purposes.

The importance of domesticating the buffalo was brought to the attention of the Agricultural Division of this Office by the Hon. E. Thayer, Chairman of the Committee on Public Lands of the House of Representatives, in a letter to the Secretary of the Interior, accompanying a communication from Colonel Daniel Ruggles, U. S. A., together with a proposed resolution. The following is an extract from the reply submitted to Congress upon the subject:

"It is beyond a doubt that the buffalo, which once roamed over this entire continent, has gradually disappeared from his former haunts, and is now restricted to the most distant prairies of the Northwest, and the gorges of the Rocky Mountains. Judging from the past, and the active causes leading to inevitable extermination, the continuance of this animal, without the aid of domestication, is certainly questionable.

"The buffalo has ranged as far north as Slave Lake, in latitude 63° to 64°, and as low as 33° in New Mexico; and it would be rash to say that any part of this continent has been unfrequented by him.

"The buffalo is too well known to require any special description of its appearance or habits. In its osteology there is a marked difference from that of the ox species as found in every part of the world, the buffalo having fifteen ribs on each side, while the common ox has only thirteen. The civilized man, equally with the savage, appears to have pursued a course of wholesale slaughter, more for pleasure than for the satisfaction of his wants.

"Perhaps no animal with which we are acquainted possesses such remarkable properties or qualities. His migratory habits and fitness for great extremes of heat and cold are the results of 'natural selection and the struggle for existence' for untold centuries, by which he has arrived at a vigor of constitution, fleetness, and muscular strength rarely, if at all, met with in the ox tribe. These are qualities of great value which cannot be disregarded, and particularly when we consider the direct and indirect advantages that judicious crossings of domestic animals have bestowed upon civilization to an extent not to be calculated.

"A full-grown male buffalo will weigh from 1,200 to 2,000 pounds, and even more. In winter, his whole body is covered with long, shaggy hair, mixed with much wool : on the forehead this hair is a foot long. The Indians work the wool into cloth, gloves, stockings, &c., which are very strong, and look as well as those made from the best sheep's wool. The fleece of a single animal has been found, according to Pennant, to weigh as much as eight pounds.

"The dressed buffalo robe is esteemed everywhere on this continent and in Europe. It is used by the Indians in lieu of blankets for clothing, and as a covering to their habitations. In the North and Northwest it is an indispensable accompaniment to the traveller.

"The flesh has been extolled by those who have eaten of it, and

bears the same relation to beef that venison does to mutton ; and all concur in their praises of the hump as at once rich, tender, savory, and never cloying.

"The hoofs and horns are converted into cups, spoons, powder-flasks, &c., while the bones, independently of other uses, when broken and boiled, yield an oil or marrow which is used for culinary purposes ; and one animal has given as much as 150 pounds of tallow.

"For military purposes, the buffalo, if domesticated, would appear to be particularly adapted, perhaps more so than any other animal, not excepting the camel. His great endurance, fleetness and strength would make him efficient as a beast of burden and for draught ; and when no longer needed, he could be slaughtered for food.

"If, by crossing the buffalo upon our domestic stock, we could gain the qualities of fleetness, strength of constitution, and muscular vigor, with the chances for properties not to be calculated in advance, such results should not be undervalued. Neither should we lose sight of the possibility of the cross proving free from those diseases and epidemics which occasionally make such havoc among our domestic cattle. An indigenous race may be expected to possess, in this respect, special qualities which would render a cross with it highly advantageous.

"The domestication of the buffalo has been accomplished to a limited extent in more than one instance ; and its feasibility is placed beyond a doubt by the experience of Mr. R. Wickliffe, of Kentucky, who has bred and crossed them with our native cattle. Any experiments, to be reliable, should extend over a series of years, and would be attended with considerable expense ; and it is believed that an enterprise of such great magnitude demands the constant and vigilant attention of intelligent agents, to whom it should be committed as a special charge."

In the progress of arrangements for the further extension and development of the Agricultural Division, it is deemed advisable to commend to the consideration of the Agricultural Societies of the country a more intimate union and a more decided coöperation on their part with the General Government in the great work of agricultural improvement.

Our country is vast, its climate is varied, its soils are diversified, and its products are of many kinds. This coöperation, therefore, cannot fail to be productive of salutary results ; and since the Agricultural Societies are composed of intelligent persons in the respec-

tive communities, who can readily understand the advantages of this means of promoting their own prosperity and the general welfare. application is made to them in this behalf.

Though the life of a nation may be counted by centuries, its present existence is always dependent upon the annual production of the soil. Without fertility, neither population nor civilization can abide. It is vain to expect that lands once worn out may be recuperated at will. Many who now live have seen individuals enriching themselves by exhausting the soil at the expense of the nation, and passing to their progeny untenable estates.

The land is for the good of all. Fertile soils were given to the nation as a trust, and are dispensed by the nation to the people to be used, but not abused. Fertility, the nation's endowment and hope, should hence be maintained; and, in order that the public at large may be impressed with these truths, and that the agricultural portion of the people may be brought into active coöperation with the Government, the aid of Agricultural Societies is thus invited in procuring agricultural statistics and reliable information upon subjects affecting agriculture, by which the whole community may be benefitted and civilization advanced.

This object may probably be best attained by the adoption of a system for the guidance of individual members of Societies in collecting facts in relation to every branch of interest to the farmer and the planter, and in reporting them at stated intervals—quarterly would be most judicious—to each State Society for its information, for publication if desired, and especially for transmission to this Office for elaboration and subsequent use. A summary of the condition of agriculture in every part of our country may, in this manner, be obtained, of material benefit to all, from the nature and reliability of its facts and the medium and regularity of their publication.

We have now a population exceeding 30,000,000, and an area of land of more than 3,000,000 square miles. It is the duty of the government to care for this immense property, and to prevent exhaustion of the soil and depopulation. This can be done by diffusing agricultural knowledge, and by procuring new plants, and bringing into notice and successful cultivation those which may be unknown or uncultivated; by the introduction of new animals, valuable for their wool, their flesh, or other qualities; of birds, useful for their eggs, feathers, or flesh; of fish that do not naturally inhabit our

rivers, or which may have ceased to exist. To effect these great ends, it is not necessary to spend a large amount of money. It may be done without risk, and at a much less cost than is supposed by many.

The duties to be performed by this agency of the Government are onerous and responsible, and would be still more so if the views submitted in this paper were carried out. Among these present and contemplated duties I would mention the following:

1. An organized correspondence with the Agricultural Societies of the United States, and with the learned societies of the civilized world, would elicit correct statistical information which could not be collected in any other manner, and which would be of untold interest and advantage to our country and the world.

2. The publication of a Report on the subject of Agriculture, in which information could be authoritatively presented and diffused, would be of the greatest value.

3. The study of unknown indigenous plants for familiar cultivation in our own country, many of which may doubtless prove an addition of the greatest importance to our wealth.

4. Entomological investigations into the nature and history of the predatory insects which have proved so injurious to our crops of cereals, fruits, &c., and also to timber.

5. Questions of the highest moment and variety, connected with agriculture, requiring chemical aid and investigations in the field as well as the laboratory.

6. Familiar examples of special modes of culture, such as irrigation, might be put into operation and opened to the examination and study of the public, who would thus have ocular demonstrations of the methods of renovating lands, of keeping them in a constant state of fertility, and of producing crops which cannot be obtained in any other way without further outlay than by the use of water. Thousands of acres in the South, now waste and entirely unproductive, might by such means be brought to produce large crops of grass, which cannot be grown in our southern climate as the lands are now cultivated. That which is looked upon as impracticable would thus become feasible and profitable by means of irrigation.

7. The stocking of our rivers with fish such as do not live in them is a matter of great interest, and can only be carried out by the Government. We may judge of its importance when we understand that

one million brood of salmon, without special attention or care, will in two years produce ten millions of pounds of the most healthful food. This subject has not only attracted the attention of European governments, but it has been repeatedly carried into successful operation there, and, upon a limited scale, in a section of this country.

These, with other subjects, necessarily come under the consideration of the Agricultural Division.

A celebrated statesman has remarked that "Agriculture feeds us; in a great measure it clothes us; without it we could not have manufactures, and we should not have commerce; they will stand together; but they will stand together like pillars, the largest in the centre, and that is agriculture."

By calling in the aid of science, and by the introduction and acclimation of new and valuable plants and animals, new sources of wealth are created and new industrial occupations are opened up for an increasing population, while our home markets are improved and we become less dependent upon other countries. (By organizing with distant nations a system of exchange of the most useful and best developed productions within the limits of their respective climates, the Agricultural Division will be performing a most important duty, and one which cannot fail to be highly beneficial to our country. Foreign governments have expressed a willingness to promote this object. Many of our diplomatic and consular agents are equally desirous of showing their appreciation of the importance of this work, and have proved it by forwarding, together with various useful seeds and plants, interesting information which can be advantageously laid before our people.)

The duties of a chemist in connexion with this division are most important. We should be able to give information upon all questions of general interest relating to agriculture, as connected with the sciences, such as the analysis of soils and of all other substances, the effects of geological formations on soils, and the composition of the divers mineral substances. In the yearly Report it is important to give a summary of the advancement of this science connected with agriculture, and for this he should have the acquirements which would enable him to discriminate with accuracy. But there are many other branches of knowledge, most of them having a direct influence upon the agricultural prosperity of the country, which would fall naturally into the class of duties assigned to his Office, including

metallurgy and the development of the mineral wealth of the country, subjects much neglected to the manifest detriment of the prosperity of the country. Other nations consider them of such consequence that they have public schools to instruct in these branches, under the immediate jurisdiction of the government. If we cannot do this, much good may yet be done in indicating what has failed and what has succeeded in other countries, and thus making the time and attention bestowed on them there subservient to our advantage.

In many ways the government would receive direct benefit from the establishment of an efficient chemical laboratory. In the selection of the materials of which the public buildings are constructed grave errors have been made. The Executive Mansion, the old or central portion of the Capitol, of the Patent Office, and of the Treasury Department are instances in point, their walls now decomposing and disintegrating, and requiring the constant use of paint to preserve them from destruction. This would have been avoided had there been an officer of the Government competent and authorized to indicate the defects and advantages of the different materials. Such considerations always precede the creation of public buildings in Europe. A material may answer for one construction and be entirely unsuited to another, or it may be useless in any edifice. Not only in regard to the public buildings, but to all other works, is advice of this nature important. Certain rocks undergo decomposition in contact with salt water. It is therefore necessary that science should aid in designating those proper to be used in works in which durability is so great a consideration. The durability of the timbers of our vessels of war, and the appropriateness of the paints applied for their preservation, have engaged the attention of the Government and called into requisition the judgment of enlightened men ; but surely there would be advantage in having a responsible authority at hand to consult on such subjects as each successive case is presented, rather than confide in less responsible yet more interested parties. The adaptedness of various kinds of iron to certain uses is also an important subject within the range of duties committed to such an officer. It is true that the architects, the civil engineers, the naval constructors and engineers, and the engineers of our army have all approved themselves well in the judgment of the world ; but it may be affirmed with equal confidence that the suggestions herein made, and attempted to be enforced by these remarks, will meet with a peculiarly approving

response from the intelligent and accomplished officers of the classes named, all of whom fully appreciate the disadvantages to which the Government is subjected from the want of a properly constituted and appointed laboratory of chemistry and metallurgy. But the primary necessity for such an establishment is in its connexion with agriculture. No true assistance can be given to the farmer in which the results of chemistry do not bear a part. The extraordinary progress which agriculture has made within a quarter of a century is due to it. The prospects for advancement in that vast interest are greater now than ever before, and their realization will doubtless lead civilization to the goal most ardently desired by the majority of mankind.

I have already shown that the want of a proper understanding of the nature of the soil, and of the arts based upon its cultivation, is the cause of the melancholy spoliation of so much of our land in this country and throughout the world. As the science of chemistry takes cognizance of the properties of all substances, and of their action upon each other, its varied and multiplied connexions with all that appertains to agriculture is without limit.

Particular attention has been paid to the management of this Division, and the improvement of the work performed. Large masses of letters and documents, the accumulation of years, are being classified and arranged for reference and use. Books better suited to its requirements have been opened, and the work systematized and simplified through the skilful labor of assistants, whose capabilities and fidelity it is alike my duty and my pleasure to commend.

How far it is accordant with the true interests of the Patent Office and with the rights of inventors to continue the administration of agricultural affairs under the ægis of that Office; how far it accords with verity to hold the Commissioner of Patents to responsibility before the country and the world for the performance of duties of which in the nature of things he cannot be cognizant, for the expression of opinions he cannot have matured, and for the promulgation of scientific discoveries in fields his accustomed pursuits have seldom or never permitted him to traverse, are regarded as proper and important inquiries at the present era, without respect to the converse of the several propositions implied, namely, that operations that are

sui generis should not be embarrassed by incongruous alliances, but that the labor and responsibility involved, and, it may even be added, the honor of all creditable achievement, should fall upon the real agents in their consummation.

THOMAS G. CLEMSON,

Superintendent of Agricultural Affairs of the United States.

JANUARY 29, 1861.

The collection of the agricultural statistics of a country is of such vast and manifest importance that the following circular and accompanying questions were prepared and have been distributed to all the agricultural societies in the books of the Agricultural Division. It is hoped that it may induce, on the part of agriculturists generally, increased attention to the necessity of observing and noting every fact bearing upon the productive resources of the country:

AGRICULTURAL DIVISION UNITED STATES PATENT OFFICE,
December 15, 1860.

SIR: In the progress of arrangements for the further extension and development of the Agricultural Division of this Office, it is deemed advisable to commend to the consideration of the agricultural societies of the country a more intimate union and a more decided co-operation on their part with the general government in the great work of agricultural improvement.

Our country is vast, its climate is varied, its soils are diversified, and its products are of many kinds. This co-operation, therefore, cannot fail to be productive of salutary results; and since the agricultural societies are composed of intelligent persons in the respective communities, who can readily understand the advantages of this means of promoting their own prosperity and the general welfare, application is made to them in this behalf.

Though the life of a nation may be counted by centuries, its present existence is always dependent upon the annual production of the soil. Without fertility, neither population nor civilization can abide. It is vain to expect that lands once worn out may be recuperated at will. Many who now live have seen individuals enriching themselves by exhausting the soil, at the expense of the nation, and passing to their progeny untenable estates.

The land is for the good of all. Fertile soils were given to the nation as a trust, and are dispensed by the nation to the people to be used, but not abused. Fertility, the nation's endowment and hope, should hence be maintained; and in order that the public at large may be impressed with these truths, and that the agricultural portion of the people may be brought into active co-operation with the government, the aid of agricultural societies is thus invited in procuring agricultural statistics and reliable information upon subjects affecting agriculture, by which the whole community may be benefited and civilization advanced.

This object may probably be best attained by the adoption of a system for the guidance of individual members of societies in collecting facts in relation to every branch of interest to the farmer and the planter, and in reporting them at stated intervals—quarterly would be most judicious—to each State society, for its information, for publication, if desired, and especially for transmission to this Office for elaboration and subsequent use. A summary of the condition of agriculture in every part of our country may in this manner be obtained of material benefit to all from the nature and reliability of its facts and the medium and regularity of their publication.

If these suggestions shall receive the approval of each State agricultural society, it is recommended that the County agricultural societies be requested to appoint a committee of one or more gentlemen deemed fitted for the important work proposed; and, to facilitate their labors, a series of questions has been prepared and is hereto appended.

I have the honor to be, yours, very respectfully,

THOMAS G. CLEMSON, *Superintendent.*

S. T. SHUGERT, Esq., *Acting Commissioner of Patents.*

INTERROGATORIES RELATIVE TO AGRICULTURAL STATISTICS

Area of county in square miles and acres?
Number of inhabitants to a square mile?
What is the relation of land to sea-level?
Assessed value of real and personal estate?
Number of acres improved?
Number of acres unimproved?
Cash value of acres improved?
Cash value of acres unimproved?
Maximum and minimum of farms, exclusive of buildings?
Value of farming implements and machinery?

Number and value of live stock?
Names of staple crops?
Quantity of each?
Value of each?
Acres of land worn out?
Cause of sterility?
What manures are applied?
What is the character of the soil and the underlying rock?
What minerals abound?
What attention is paid to forest culture?
What to cultivation of medicinal plants and herbs?
What to raising of seeds for use or sale?
How many head of live stock lost by disease this year?
What the nature of the disease?
What grasses are most cultivated?
How many nurseries in the county?
In how many stores are seeds sold?
Value and quantity of seeds sold?
How many agricultural warehouses?
How many manufactories of agricultural implements?
How many manufactories of drain-tiles?
Is draining much practiced?
Is irrigation practiced?
What crops are injured by insects, and to what extent?
By what insects?
Bee culture—number of hives and value of product?
Will you please to say by what action the Agricultural Division of the United States Patent Office can best serve the cause of agriculture in your county?

OPERATIONS AT THE GOVERNMENT EXPERIMENTAL GARDEN.

A suitable depository for plants designed to be introduced to the United States or disseminated throughout the land must be adequate to the following uses, viz:

1. Receiving and preserving all seeds, bulbs, cuttings, and plants, obtained from other countries and from various regions of our own.
2. Testing by culture the adaptation of plants to various soils and climates.
3. Determining by experiment the best methods of cultivating particular plants.
4. Modifying the qualities of plants by hybridization and improved culture.
5. Propagating plants preparatory to distribution.
6. Packing, labelling, and despatching, by mail and otherwise, such plants, seeds, &c.

The area of five acres in a central part of Washington, heretofore described as prepared for these purposes, is a part of the grounds reserved by the Government for ornamental uses; and its present application, combining both utility and beauty, is hence commended as judicious and economical until experience shall demonstrate the necessity of more ample and more eligible accommodations.

A recital was given in the report for 1859 of a portion of the principal subjects of culture and propagation at this garden, which it is now proposed to resume and continue in the manner of a review of the various enterprises in progress.

Tea.—Thirty-two thousand plants, propagated from seeds, were distributed throughout the United States in the period between September, 1859, and April, 1860. Little more can now be said of them than that, from Maryland to Louisiana and Texas, they are known to have taken root and prospered, though exposed to all the severities both of summer and of winter, except that there is reason to believe that very many have perished from the want of the ordinary care demanded by every tree in the first year of its growth; and with the additional exception, extraordinary as it may appear, that, in a number of instances, the plants were placed in the ground as received from the garden, with the moss and packing around them, instead of being carefully divested of their coverings, and moistened before planting when found in a dry condition, and, of course, have never manifested any signs of life whatever. In the District of Columbia, plants properly attended to, though

wholly unprotected, and though severely pruned, are full 18 inches high and 14 inches in the diameter of their branches; while in portions of North Carolina and of Texas the growth has been even more vigorous. In the second year much greater progress will be made, wherever proper skill and attention shall be devoted to them. The distribution in the spring of 1861 will consist of about 8,000 plants, all propagated from cuttings, and therefore capable of maturing earlier. It is purposed to send forth annually a like number thus produced, in order to replace losses and to supply the continued demand, until private interest shall discover in the enterprise an adequate incentive to its effectual prosecution.

Grapes.—About 135 varieties of grapes are now in the course of experimental culture and propagation. Many of these are being fruited for the purpose of improvement by hybridization, mainly with the view of their adaptation to wine-making, especially by the amalgamation of native and foreign varieties, upon which process the hopes of intelligent cultivators of the vine now mainly rest. The following is a list of native grape vines to be distributed prior to April, 1861; all of them, except the Catawba and Isabella, being comparatively new varieties, and but little known in general cultivation, viz:

NATIVE GRAPES FOR DISTRIBUTION.

Catawba.—Though reputed to be of northern origin, this grape is probably a native of Maryland. It was first brought to public notice by Major Adlum, of Georgetown, D. C The vine and foliage resemble those of the Isabella; it is prolific; berries medium, round, pale red, musky aroma; slightly pulpy; ripening late, it does not succeed well north of Pennsylvania and Ohio; it is the most general reliance for wine-making in the regions to which it is adapted.

Concord.—Mr. E. W. Bull, of Concord, Massachusetts, produced this grape from the seed. It is one of the hardy, productive, and vigorous growers among native varieties, is not subject to the attacks of mildew or dry rot, and prospers in all portions of the United States. The fruit is large, oval, black, sweetish, though pungent and musky, improving with the age of the vine; ripens at Washington in the latter part of August; and is a fair table grape, but more desirable for wine-making.

Delaware.—Whether this is a native grape or a seedling of some foreign variety is a contested point, but the general opinion ascribes it to native origin. It was brought into public notice by Mr. Thompson, of Delaware, Ohio, who is said to have traced it to Mr. Paul H. Provost, of Hunterdon county, New Jersey. It is, when perfected, the best flavored of American grapes. The clusters are small and compact; berries, small and round, light red, juicy, pulpless, and very sweet; is an excellent table grape, and will become popular for wine-making. It is subject to mildew; has proved a slender grower in Washington, where it ripens late in August; but the testimony of cultivators is conflicting on this head. It is hardy, and adapted to the middle and northern States.

Diana.—Mrs. Diana Crehore, of Milton Hill, near Boston, Massachusetts, produced this variety from seed of the Catawba. It was first brought into public notice by Hovey's Magazine, in 1844. It is hardy, a strong grower, very prolific, and ripens even further north than Boston late in September, excelling its parent stock in these particulars. The clusters are of medium size and compact; berries, light red, small, round, sweet, and slightly pulpy. It keeps well throughout the winter, is valued for table use, and will become profitable for wine-making. For general cultivation it is one of the most desirable varieties.

Hartford Prolific.—A seedling, originated at Hartford, Connecticut, by Mr. Steele. It is hardy, vigorous, and productive; clusters compact and of medium size; berries round—aroma slightly foxy; flesh sweet and slightly pulpy; ripens at Washington early in August; is best adapted to the central and northern States.

Isabella.—Originating in South Carolina, this well-known variety was introduced to the North by Mrs. George Gibbs, after whom it is named. It is an excellent variety for table use when cultivated north of Maryland, though inferior in its native South. It is prolific; berries oval; when ripe, pulpy and sweet, with slightly musky aroma; large, black, with bluish bloom; clusters, loose; ripens at Washington in September.

Rebecca.—This grape was originated by Mr. E. M. Peake, at Hudson, New York, about 1850, but was not brought into public notice until three or four years later. It grows well generally, but very rapidly for the first four years. The clusters are from four to eight inches long, and tapering; the berries of medium size, oval, green when shaded, of golden hue in the sun, very juicy, sweet, and pulpless, and suited for table use. It prospers south of Massachusetts—best, probably, in the latitude of Pennsylvania, where it ripens in September. The vine is somewhat subject to mildew.

Union Village.—The Shakers, at Union village, Ohio, originated this grape from seeds of the Isabella. It was brought into public notice by Mr. Longworth, of Cincinnati, about

1854. It is best adapted to the central and northern States, growing vigorously, and producing very large berries in large and compact bunches; is pulpy, juicy, sweet; probably the best black native grape in cultivation. In Washington, ripens in September.

FOREIGN GRAPES FOR DISTRIBUTION.

The following list of grapes of foreign origin, to be distributed in limited quantities in the same period, is here given, explanations of their names and individual characteristics being necessarily deferred. It may, however, be stated that they are all believed to be of tender constitution, and best adapted to regions south of Pennsylvania. They are wine grapes in their native countries, but are, as yet, cultivated only for table use in this country:

Sweet Water, (Dutch.)—This grape has long been familiar to the graperies of the United States, and has been cultivated in vineyards as far north as Massachusetts, by means of laying the shoots on the ground as soon as the leaves are fallen, and covering them with straw or dry leaves. It is a medium grower; liable to every form of mildew when grown in moist soils; prolific; clusters loose, shouldered, and of medium size; berries medium and round, very light green, pulpless, sweet, and watery; a table grape of limited demand.

Bakator.	Hungarian.	Muscatel, white.	Hungarian.
Chasselas, white.	"	Puisin, blue.	"
Dinka, green.	"	Puxesin, blue.	"
Dinka, red.	"	Riner, red.	"
Honey, white.	"	Rosas.	"
Furmint.	"	Schenkem, white.	"
Katarka, blue.	"	Semedria.	"
Katarka, white.	"	Sheeptails.	"
Keskecsocs.	"	Silver, white.	"
Muscatel, green.	"	Todar, white.	"
Muscatel, red.	"	Tokay.	"
Muscatel, yellow.	"	Tokay, white.	"

NATIVE GRAPES IN COURSE OF PROPAGATION.

The following list embraces the varieties of native grapes now under experiment and in course of propagation. They are, with few exceptions, adapted to culture in the northern and middle States, and most of them will prosper as far south as the Catawba or Isabella:

———, *seedling of the Concord:* Fruit black and large; said to be superior to the parent stock.

Henshaw: Red; sweet; medium size.

Dracut Amber: Light red; medium; pulpy; agreeable flavor.

Trollinger.

Lincoln Downer: Well-reputed.

Sage Grape: Red; agreeable flavor.

Bartlett.

Plymouth: White.

Clinton: Black, round, small, sweet, juicy, somewhat pulpy; ripens early.

———, *seedling:* White, juicy, sweet, slightly pulpy; a vigorous grower.

———, *seedling:* Red.

Black Fox: Large, juicy, pulpy; agreeable flavor, though tart; vigorous grower.

Red Fox: Of like characteristics, but smaller.

Crystal: White, sweet, juicy, somewhat pulpy; medium size.

Mustang: Black, small, pulpy; pleasant flavor; vigorous grower.

———, *seedling:* Red, small, juicy; agreeable flavor.

Graham: Purple, juicy, sweet; slightly pulpy; medium.

Elbling.

Parker's Rocky Mountain Seedling.

Wise.

Tennessee.

Herbemont: Red, juicy, sweetish, small; vigorous growth; (will not succeed, unprotected, north of Maryland.)

Devereaux: Purple, juicy, sweet; medium size; vigorous growth; (will not succeed well south of Maryland.)

Virginia: Red, large, pulpy; vigorous growth.

Ontario: Black, very large, slightly pulpy, juicy; vigorous growth.

Arrot: Red, medium size, juicy, slightly pulpy.
Herbemont's Madeira: Red, medium size, sweet; vigorous growth; (will not succeed, unprotected, north of Maryland.)
Black September: Small, juicy, unproductive.
Schuylkill.
Early Frost: Black, medium; agreeable flavor; somewhat pulpy.
Everett.
Parker's Improved Isabella: Black.
Raabe: Purple, small, sweet, prolific.
Guesta: Blue, sweet, slightly pulpy; agreeable flavor.
Currant: Black, small, sweet, juicy.
To-kalon: Red, sweet, juicy, slightly pulpy; medium size.
Brinkley: Black, small, juicy, somewhat pulpy.
Ketchum: Black, sweet, slightly pulpy; medium size; vigorous growth.
Franklin: Black, sweet, small, somewhat pulpy; vigorous growth; ripens early.
Grevaduly.
Rulænder.
Northern Muscadine: Red, foxy, sweetish, juicy; clusters compact; vigorous; ripens early.
Woodford: Purple, juicy, pulpy, sweet; vigorous growth.
Wyoming: Black, juicy, somewhat pulpy; vigorous growth.
Emily: Pale red, juicy, sweet; vigorous grower.
Lenoir: Black, small, juicy, very sweet; vigorous grower; (will not grow, unprotected, at the North.)
Baldwin's Lenoir: Like characteristics.
Washita.
Leogan: Dark blue; medium; juicy, somewhat pulpy.
Canby's August: Black, juicy, sweetish.
Anna: White, juicy, sweet, slightly pulpy; a desirable variety.
Saluda: Blue, large, juicy, somewhat pulpy; very vigorous grower.
Cassidy: White, sweet, juicy; vigorous grower.
Garigues: Dark purple, oval, medium, juicy, sweetish, pulpy.
Scuppernong: Yellowish, large, round, sweet, pulpy; vigorous grower.
Elsinburgh: Black, small round, thin skin, pulpless, sweet and juicy.
Clara.
Louisa: Black, large, juicy sweet, somewhat pulpy; vigorous grower.
Blue Oporto: Dark blue; medium size, round; juicy, sweet, somewhat pulpy.
———*, seedling:* White, medium, very sweet, juicy, slightly pulpy; prolific.

About thirty varieties, received without names from different parts of the United States, will be grown and fruited in pots at as early a day as possible; if then found superior or fully equal to the best varieties at present in cultivation, they will be named and distributed.

FOREIGN GRAPES IN COURSE OF PROPAGATION.

The following is a list of grapes of foreign origin in course of experimental culture—all of them pulpless:

Traminer: German; medium size; red, sweet, round, delicious flavor.
Seedless: Egyptian; medium, round, white, very sweet.
Lady's Finger: Egyptian; oval, very long and slender; delicious flavor.
White grape: French; large, round, sweet.
Black Morocco: African; large, round, sweet, fleshy.
Black Muscat of Alexandria: Egyptian; large, oval, fleshy.
White Muscat of Alexandria: Egyptian; large, oval, luscious.
Black Frontignac: French; medium, round, sweet; clusters small.
White Frontignac: French; medium, round, sweet; clusters small.
Black Hamburg: Holland; large, round, sweet; clusters large.
Grizzly Frontignac: French; large, round, very sweet.
Decan's Superb: Large, round, white, sweet.
Golden Chasselas: French; medium, round, luscious.
Lisbon Red: Portuguese; large, round, sweet.
Black Prince: ——; large, oval, black; clusters large.
Hausteretto: German; large, round, red, sweet.
Reine de Nice: Italian; medium, round, white, sweet.
Joslyn's St. Alban's: English; large, round, white, luscious.
Wilmot's Black Hamburg: English seedling; large, round, very sweet.

Cannon Hall Muscat: English; very large, oval, luscious.

Bowood Muscat: English; medium, round, golden, very sweet; *new variety.*

White Syrian: Palestine; very large, oval, sweet; clusters very large and heavy, and shouldered.

Black Barbarossa: African; medium; round, sweet.

Red Lombardy: Italian; large, round, sweet.

Santa Crux: Mexican; *new variety.*

Golden Hamburg: English seedling; medium, round, very sweet; *new variety.*

El Paso, No. 1: Of foreign origin, but long cultivated in Texas; large, round, blue, sweet, fleshy.

El Paso, No. 2: White; other characteristics similar to No. 1.

Charlesworth Tokay: English; medium, oval, white, luscious.

Black Damascus: Palestine; large, round, sweet; clusters large.

Raisin des Carmes: French; medium, round, red, sweet.

Miller's Burgundy: French; large, round, black, sweet.

White Nice: Italian; large, round, sweet; clusters large; produces sherry wine.

West St. Peters: English; medium, round, black, sweet.

Zinfindal: Large, round, black, sweet.

PLANTS FOR DISTRIBUTION.

OSIER WILLOW, *(Salix viminalis.)*—This tree, though many years in culture in the United States, is unknown in many regions, and has therefore been selected for dissemination, especially in view of the fact that it will prosper wherever moist lands prevail, and near water-courses everywhere. About 2,000 plants were distributed in the spring of 1860; and 8,000 are ready for distribution in the spring of 1861.

CAROB TREE, *(Ceratonia siliqua.)*—The arrival of seeds and cuttings of this tree from Palestine was noted in the Report for 1859. It has been successfully propagated at this garden; and a limited number of plants have prospered in the air in several situations south of Virginia. About 8,000 plants will be distributed in the spring of 1861. In addition to its desirableness as a producer of fruit, it will prove valuable in the southern States as a hedge plant when judiciously pruned. Rev. James T. Barclay, D. D., a Christian missionary from the United States, from whom this and other plants of Palestine have been received, writes as follows: "This fruit is largely exported to Russia, where, as well as here, it is much esteemed as an occasional article of diet, and for a beverage brewed from it. It can probably be raised in every portion of the United States south of Pennsylvania. No special directions are necessary for the management either of the cuttings or seeds. It is an admirable shade tree."

SESSABAN.—This is probably a variety of the *Mimosa.* It is an evergreen in Syria, and will doubtless prove such in the southern States, but a deciduous tree in the North. Doctor Barclay says it has a very delicate leaf and a pendent, globular flower, somewhat like the sycamore ball, and highly odorous. It is esteemed as an ornamental tree, but is chiefly valued as a hedge plant. It is believed to be a rapid grower. A limited number were distributed in the spring of 1860; 3,000 will be distributed in the spring of 1861.

ST. JOHN'S WORT, *(Hypericum corymbosum.)*—This shrub, though indigenous to the southern States, is but little known throughout the country; yet it has proved hardy in the District of Columbia, and will probably succeed still further north. It is an ornamental shrub, blooming early in the spring. There will be a distribution of 3,000 plants in the spring of 1861.

BERBERY, *(Mahonia repens.)*—This ornamental evergreen shrub is indigenous to Texas, and somewhat known in various sections of the country. It is of vigorous growth and blooms early in the spring; the flowers are yellow, and succeeded by red berries, which remain throughout the winter.

STONE PINE, *(Pinus pinea.)*—This tree, though common in Syria and in Southern Europe, is but little known in the United States. It is of loose growth, with straggling pendent branches; the foliage handsome, of bluish tinge. It yields large seeds in great abundance, which are used as occasional food by the peasantry of the countries in which it grows. A small number of plants were distributed in the spring of 1860, and about 1,000 will be sent out in the spring of 1861.

ARBOR VITÆ, *(Biota Chinensis)*—This tree has been grown from seeds imported from China by the Patent Office. It is a new and very ornamental variety, and may be regarded a very desirable acquisition to our evergreens. It is compact and bushy, and a vigorous grower, and is said to retain its lower branches, and consequently preserve its pyramidal form, even in extreme old age. In the spring of 1861 there will be 1,000 ready for distribution, and an increased number in the following year.

PLANTS IN COURSE OF PROPAGATION FOR FUTURE DISTRIBUTION.

Under this head may be classed a large number of ornamental, medicinal, and edible plants, the seeds, bulbs, and cuttings of which have been received from Palestine through the agency of Rev. James T. Barclay. A portion of these were described in the Report for 1859; and descriptions of others are hereto subjoined, as follows:

COLOCYNTH, (*Cucumis Colocynthis, seeds from Palestine.*)—A portion of the seeds of this plant have been distributed among agricultural societies in the central and southern States. It is an annual creeping vine, and may be cultivated as cymlins and cucumbers are. Its medicinal properties are well known to the profession, and its culture is very generally desired. Dr. Barclay says that it grows luxuriantly on the plains of Sharon, a single vine producing more than a hundred fruit.

PISTACHIO, (*Pistacia vera, seeds from Palestine.*)—This tree will doubtless succeed well south of Virginia in this country. It is described by Rhind (*Vegetable Kingdom*) as growing from twenty-four to thirty-five feet high, with heavy twisting branches, covered with a thick grayish bark. The leaves are large and oblong. The flowers are small, and of a greenish color. The fruit is a thin shelled, oval, tapering nut, about the size of an olive. The nuts are produced in bunches, and are commonly in profusion. Some think them more agreeable in flavor than the hazel nut or almond. They are exported to those parts of Europe where the tree does not flourish.

This tree is indigenous to Asia Minor, and is very abundant in Syria. It is much cultivated in Sicily for the sake of its nuts. It succeeds in dry, stony, calcareous grounds, but thrives in a sandy or moist soil. In forming plantations, trees of different sexes must be selected to insure fructification. One male should be allotted to five or six females; and, to avoid mistakes, young grafted stocks should be procured, or suckers from the foot of an old tree. The male flowers are produced first; and some pluck them while yet shut, dry them, and afterward sprinkle the pollen over the female tree. But in Sicily the method is to wait till the female buds are open, and then to gather bunches of male blossoms ready to blow; these are stuck into a pot of moist mould and hung upon the female tree till they are dry and empty. This method is very effective. Some gardeners ingraft the male bud upon the female tree. The wood is hard and resinous.

According to Pliny, pistachio nuts were first brought to Rome about the reign of Tiberius, and probably the tree was introduced into Italy at the same period. It has been long cultivated in Spain, Portugal, and the south of France, and, when properly protected, yields fruit even at Paris. It is more hardy than the orange, and thrives in the same soil and climate with the olive.

DATE, (*Phœnix dactylifera, seeds and plants from Palestine.*)—This palm is probably adapted only to warm localities in the southern States, where it will prove an evergreen. It attains a height of sixty feet. That it has not borne fruit in greenhouse collections in England and the United States is doubtless owing to the fact that, although the wild date will produce fruit without assistance in transferring the seminal element from the male to the female tree, in a state of cultivation, even though in the open air, it fails to do so.

PRICKLY PEAR, (*Cactus opuntia, seeds from Palestine.*)—This plant will thrive best in dry, stony, or calcareous soils in the central and southern States. The fruit, which is abundant on the mature plant, is ovoid, about as large as the fig of commerce, sweet, and juicy, but covered with small spines, which irritate the tongue when not carefully removed. It is very wholesome.

SQUILL, (*Scilla maritima, bulbs from Palestine.*)—This perennial herbaceous plant has a large bulbous root, coated like the common onion, of grayish color, and abounding in a thick juice; the flower stem is round, smooth, and succulent, and from two to three feet high. The leaves are from twelve to fourteen inches long, and pointed. It is cultivated in Spain, Sicily, and Palestine, and prefers sandy soils. This bulb was known to the ancient Greeks for its medicinal properties, for which it is still well known and highly valued. It will, no doubt, succeed well south of Virginia, like most of the Syrian plants. Its tenacity of life is very great, bulbs having been known to grow after having been buried in sand heated above the temperature of boiling water. It may be propagated from seeds and from offshoots of the bulb.

OLIVE, (*Olea Europea, cuttings from Palestine.*)—This tree is little known in the United States, though its products are consumed in large quantities, the imported oil of olives alone exceeding in value half a million dollars a year. Some early attempts to introduce the tree have been recorded, but no satisfactory account thereof has been preserved. Mr. Jefferson, writing from Paris in 1787, remarked that, although the olive was a tree the least known in America, it was the most worthy of being known. "Of all the gifts of Heaven to man,"

said he, "it is next to the most precious, if it be not the most precious. Perhaps it may claim a preference even to bread, because there is such an infinitude of vegetables which it renders a proper and comfortable nourishment. In passing the Alps at the Col de Tende, where they are mere masses of rocks, wherever there happens to be a little soil there are a number of olive trees and a village supported by them. Take away these trees, and the same ground in corn would not support a single family. A pound of oil, which can be bought for three or four pence sterling, is equivalent to many pounds of flesh by the quantity of vegetables it will prepare and render fit and comfortable food. Without this tree the country of Provence and territory of Genoa would not support one-half, perhaps not one-third, their present inhabitants. The nature of the soil is of little consequence, if it be dry. The trees are planted from fifteen to twenty feet apart, and, when tolerably good, will yield fifteen or twenty pounds of oil yearly, one with another. There are trees which yield much more. They begin to yield good crops at twenty years old, and last till killed by cold, which happens at some time or other, even in their best positions in France. But they put out again from their roots. In Italy (I am told) they have trees two hundred years old. They afford an easy but constant employment through the year, and require so little nourishment, that if the soil be fit for any other production, it may be cultivated among the olive trees without injuring them." "Wherever the orange will stand at all, experience shows that the olive will stand well, being a hardier tree." "This is an article the consumption of which will always keep pace with its production. Raise it, and it begets its own demand." "Cover the southern States with it, and every man will become a consumer of oil within whose reach it can be brought in point of price." "Were the owner of slaves to view it only as the means of bettering their condition, how much would he better that by planting one of these trees for every slave he possessed! Having been myself an eye-witness to the blessings which this tree sheds on the poor, I never had my wishes so kindled for the introduction of any article of new culture into our own country."

The olive is a low, branchy, evergreen tree, rising from twenty feet to thirty feet, with stiff, narrow, bluish-green leaves. The flowers are produced, in small axillary bunches, from wood of the former year, and appear in June, July, and August. It is supposed to be originally from Greece, but is naturalized in the south of France, Italy, and Spain, where it has been extensively cultivated for an unknown length of time. Near Terni, in the vale of the cascade of Marmora, is a plantation above two miles in extent, supposed to be the same plants mentioned by Pliny as growing there in the first century. With protection from severe frost, Miller says, "it may be maintained against a wall in the latitude of London." In Devonshire some trees have stood the open air for many years.

A plant that will prosper in barren soil, and that promises so much profit, should not be omitted, even though many years must pass from the time of its introduction until its fruition. It may be propagated from seeds, cuttings, layers and suckers, and by inoculation, which last made is generally preferred by culturists. It is also propagated by the knots or excrescences from the main stalk of the tree.

The olive will doubtless succeed in the uplands of North Carolina and South Carolina, and generally in dry situations in Tennessee, and southward to Florida.

KHALCAS, (*Calladium species, tubers from Palestine.*)—This plant will succeed best in moist situations in the middle and southern States. It forms a number of ovoid tubers, nearly as large as hens' eggs in the first year, which probably increase in size when permitted to remain longer in the ground. Its flesh resembles that of the yam, but is exceedingly pungent when raw; when boiled, it is very palatable. It is extensively used by the poor in Syria.

SEEDLESS POMEGRANATE, (*Punica species, cuttings from Palestine.*)—This plant is described as bearing fine fruit, much esteemed in Syria. It has highly ornamental properties, forming a desirable shrubby tree, and producing large and brilliant scarlet flowers, semi-double, in autumn. It will thrive in moderately moist soils south of the District of Columbia.

FERTILIZERS.

BY HON. THOS. G. CLEMSON, LL. D.

In the range of knowledge there is no subject more tangibly satisfactory, and none better calculated to enlarge our comprehension, and to teach us the infinite design and adaptedness of parts to a wise economy in the future, than chemical geology.

Careful observations, made in the Observatory of Paris and elsewhere, show that the temperature of the earth increases regularly a degree for every 51 feet as we descend. It is hence more than probable that the interior of the earth has been from its creation, or from incalculable time, incandescent, or in a molten state. This affords an easy explanation of the many disruptions of the solid crust of the earth which every traveller has beheld. Crystalline and pseudomorphic rocks have been thrown up through stratified formations and left at the apex, the latter anticlinal or dipping in opposite directions on the sides; and thus the relative ages of mountain ranges may be correctly estimated. Volcanic eruptions bring to the surface portions of the molten mass in varied forms and composition, and earthquakes are but symptoms of the interior agitation. This central source of caloric imparts to the surface crust a portion of its heat, and modifies the intensity of those changes which take place with the transitions of the seasons. So regular is the increase of temperature as we descend toward the centre of the earth, that we may calculate with some degree of precision from what depth hot springs arise. It is thus determined that, under the city of Paris, the temperature of boiling water would be reached at a depth of 8,212 feet.

The rocks thrown out by volcanic action bear the impress of modification by heat, being more or less crystalline in their structure, and, like the primitive rocks, granites, sienites, and porphyries, have a marked aspect, and must not be confounded with the super-imposed strata which owe their origin to the detritus resulting from the decomposition or disintegration of the older rocks; but rocks are compounds of mineral species, and these of simple substances, mostly oxyds of metals.

We know that substances combine with inconceivable intensity of force. No observer of chemical action can fail to realize sensations of amazement and profound reverence for the author of such stupendous manifestations as are exhibited even by the familiar combination of the constituents of water, or the power shown by that liquid in passing to a solid state. This power is not confined to the operations of inorganic matter, but is a constant accompaniment of vitality, and by it inert matter is made to perform its part in unison with other substances. Hence it may not be unreasonable to anticipate the time when the heterogeneous masses forming the earth may all be brought into life-existence. We are familiar with the omnipresence and continued manifestations of that power as with life itself. The imagination cannot reach the inscrutable ways of the Creator; yet that such all-pervading power exists in Nature is a truth known from all time; for it is written, "And the earth was without form and void, and darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters. And God said, Let there be light, and there was light." A magnificent recital, but stronger and more philosophical in the original, since, as Hebrew scholars interpret, "aōur" means an all-pervading fluid, filling space and mysteriously imbuing animated Nature.

Behold the power of a seed; however minute, the embodiment of a complete inherent entity. It produces promised results with unerring certainty, when all the conditions are fulfilled. It is a credit to man by the great Jehovah, and the draft will be honored as sure as the sun shall rise—as sure as effect shall succeed to cause.

In the tropics continual verdure prevails, and the vegetation of successive zones is varied and governed by irrefrangible omnipotent dispensations, apparent active life subsiding at fixed intervals of time, and its outward symbols falling when an era of rest ensues. The higher animals stand watch on earth; the sun speeds on through space, by paths unknown to man, dispensing blessings to uncounted worlds, until the welcome return of its genial rays once more revives the surface of our planet A wave of verdure now swells and rolls on again from the equator to the impassable barrier eternal at the poles.

The coincident power of the interior heat and of the sun, together with the composition of the rocks which form the earth, are subjects of the present investigation.* Were it not for the influence of the sun the entire mass of the earth would be dependent upon its own inadequate resources for the principle upon which, so far as our knowledge extends, vegetable and animal life is maintained. Without this external vivifying power the earth would be unfit for the abode of those creatures which are essential to each other, and which unitedly proclaim the glory of the Almighty. The minute and intimate actions forever in progress upon and in the earth are not only indispensable to life, but even to the preparation of the constituent elements of organized existence.

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* This subject was commenced by the writer, (*vide* Agricultural Report for 1859 page 136,) in compliance with a request from the Agricultural Division, prior to his being invited to preside over it; and is now continued under a sense of the obligation implied by that performance, restricted as it then was to assigned limits.

POTASSIUM.

The substance popularly known under the name of potash is a combination of oxygen and a metal called potassium. This metal was first separated from the alkali in 1807, by Sir Humphrey Davy, and is interesting on account of its properties, and as having been the first of its class obtained by means of the galvanic pile. Great must have been the satisfaction of the illustrious chemist when he first observed the result of the decomposition of a piece of moistened potash in an assemblage of minute globules of potassium surrounding the negative pole of the battery. Since that period different methods have been discovered by which it can be manufactured at little cost by any one desirous of becoming familiar with its properties.

Potassium is of a bluish color, is soft, and may be worked by the fingers as wax. Its lustre is eminently metallic, but cannot be retained in contact with the air. This metal must be kept under oil of naphtha, (which contains no oxygen,) because, if left in contact with the atmosphere, it will absorb oxygen and again become potash, or oxyd of potassium. It is lighter than water, its specific gravity being 0.865. At the temperature of freezing water it is brittle; as the temperature rises it first becomes soft, and then liquefies long before the thermometer reaches the boiling point; and, finally, is volatilized at a red heat, giving out vapors ot a beautiful green color. When a piece of potassium is thrown upon water its affinity for oxygen is so great that the water is decomposed, the oxygen of the water uniting with the metal with such rapidity that the hydrogen is ignited, and continues to burn until the metal is completely oxydized. If the remaining water be then examined it will be found alkaline, and capable of turning reddened litmus blue.

Substances in different electric states unite with each other. When electricity is used for their separation, the electro-negative element is attracted to the electro-positive pole, and *vice versa.* In the case of the reduction of potash, the metal of potassium, being the electro-positive element, is found at the negative pole of the battery. The specific gravity of the metal being less than water, it floats, the water is decomposed, the oxygen unites with the potassium, evolving the caloric, and causing the hydrogen arising from the decomposition of the water to re-unite with the oxygen of the atmosphere and reproduce water, which passes into the air. The combination of oxygen and hydrogen effected by a spark is always attended by a stupendous and astounding development of force; but that compound may be broken by potassium, which, as far as is known, decomposes all bodies containing oxygen; yet, by the aid of an elevated temperature, some substances, such as carbon and iron, have the power of reducing the oxyd of potassium by combining with the oxygen. The process of preparing potassium in quantity is founded upon these properties.

POTASH.

Hydrate of Oxyd of Potassium.—This substance, as known in commerce, is an impure compound of all the soluble salts extracted from wood ashes by lixiviation and evaporation to dryness. Pearlash contains fewer impurities, being prepared by a more perfect calcination in contact with the air, promoted by constant stirring, by which means the carbonaceous matter, as well as the sulphur, is dissipated. Resolution and evaporation, toward the close of the process, produce a white granular appearance.

Pure potash (vegetable alkali, caustic potash, &c.,) is solid, white, and fusible, and does not undergo decomposition at any degree of heat to which it may be subjected; but it is deliquescent, and, when exposed to the air, absorbs the carbonic acid of the atmosphere, and will consequently effervesce by the application of any of the stronger acids, such as sulphuric, nitric, or chlorohydric. It is one of the most powerful bases, and so caustic as to alter all organic substances with which it comes in contact, and it is hence used as an escharotic in surgery. Not only does it dissolve many animal substances, but also changes the nature of vegetable products, particularly when its action is aided by heat.

Potash is never found pure in nature, being always combined with acids, such as carbonic, sulphuric, chlorohydric, nitric, tartaric, oxalic, &c. That which is extracted from the ashes of vegetables is mixed with divers other salts, varying according to the vegetables from which the ashes have been procured, the nature of the soil, and the kinds of manure used in their production.

In preparing caustic potash, regard must be had to the substance used for the carbonate. That produced by reducing to ashes the tartrate of potash is the most pure. By successive crystallizations any degree of purity may be gradually attained. The *carbonate of potash*

is decarbonized by the application of caustic lime to a solution of the carbonate in boiling water, the boiling being continued for a time. The carbonate of lime, formed by the absorption of the carbonic acid from potash, precipitates, and may hence be easily separated by decantation or by filtration. To ascertain when all the carbonic acid has been removed, it is only necessary to add a few drops of acid to an equal quantity of the clear solution, when any effervescence will indicate the incompleteness of the operation. The decomposition being effected, the solution is allowed to settle, the clear liquid is decanted, and the residuum is thrown upon a filter, which may be of straw, clean sand, cloth, or paper. The evaporation should be rapid until the water is dissipated, when the product may be run into moulds, as may be desired, or allowed to cool on the sides of the evaporating pan. It should then be broken into fragments and secured in glass vases with emery stoppers. Potash thus obtained is known in commerce as potash prepared with lime. It is not absolutely pure, but contains salts, such as chlorides, sulphates, silicates, and aluminates of potash. By dissolving this potash in alcohol, and evaporating first in a still, to economize the alcohol, and finally in a silver vase, a product is obtained known as potash à l'alcohol, which is used in analyses, and may be considered the purest found in commerce.

There are few well-ordered farms in our country where ashes are not used for making lye and soap. The usual method is simply to lixiviate the ashes upon a hopper, and then boil the lye with grease to produce soft soap, which may be decomposed by the addition of salt, (chloro-hydrate of soda,) a transformation of bases thus taking place, when, in lieu of the stearate, margarate, and oleate of potash, we have salts with a base of soda, or, in other words, hard soap. This is open to criticism, as the lye is not decarbonized, and as it is at best a most wasteful mode, since the carbonate of potash does not act so readily, if at all, upon the fats. In fact, it is questioned by chemists learned in this branch whether fats combine with any other than the caustic alkali. It is certainly far better to decarbonize the carbonate of potash by quick lime, as already described. The operation will thus be rendered much more certain and more easy to regulate, and at the same time produce soap in greater quantity and of superior quality.

Potash, if not the strongest, is at least one of the strongest of the bases, and forms salts that are very permanent—all of which are soluble in water; such as are but slightly so being rare exceptions. In agriculture it is never used alone, but in combination with substances produced in the arts or found in certain localities, as geological formations, such as green sand, occurring along our eastern littoral, varieties of felspar, lavas, &c.

Potash is widely diffused throughout nature. It enters into the composition of animals and plants, and of all the soils which support vegetation; and it forms one of the constituents of the predominant rocks of which the earth is composed, such as granites, mica-schists, the sienites, lavas, basalts, &c. Where the soil is formed from a rock in which there is no potash, it would be useless to seek it, or to anticipate fertility without supplying this element. Soils formed of pure sand, supplied by the disintegration of quartz rock, are unfitted for the growth of plants. So, too, with soils, such as chalk, which contain little else than carbonate of lime. But the chalks, though comparatively poor, are not entirely free from other substances. The grass that grows on the downs, meagre as it may be, thrives because of the presence of other constituents than carbonate of lime; and it is well known that chalk, when examined by a powerful magnifier, is an agglomeration of the remains of infinitely small organisms.

The *silicate* of potash is one of the constituents of felspar and of mica; and these two mineral species, in ever-varied proportions, together with quartz, form granite, the most predominant rock, as far as known, of which the earth is constituted. Geologically speaking, it is the lowest and the highest rock known; that is to say, it forms the crystalline or molten mass of the interior of this planet; and where the overlying and more recent rocks have been upheaved, and the lines of continuity broken, the tops of the highest mountain ranges display the protruded granite. The disintegration and decomposition of this rock varies according to its composition or the preponderance of one constituent over others. Oxygen and carbonic acid are the principal agents in its chemical decomposition; its disintegration is mainly due to physical action, changes of temperature, the agency of water, &c. In the chemical changes the proto-salts of iron become per-oxyds; and those of manganese undergo a like alteration. The decomposition of the silicates of magnesia, lime, potash, soda, &c., is effected by the action of carbonic acid, derived either from the interior of the earth or from the atmosphere. In the former case, the change of the rock proceeds from the interior to the surface; in the latter, from the surface to the interior; in either case the carbonates of lime and magnesia thus formed sooner or later become bi-carbonates, and pass off in water, leaving the remains of the rock a porous mass into which water penetrates; and, through the vicissitudes of temperature in northern climates, this reduction to an earthy mass is accelerated. The composition of the crystalline and metamorphic rocks is infinite in variety; and in proportion as the proto-silicates predominate is the tendency to abrasion and decomposition, until the entire mass becomes pulverulent and fit for the sup-

port of vegetation. Alumina, as will be seen, is one of the constituents of felspar and mica. By the decomposition of these substances clays are formed, and, according to the position or elevation of their localities, deposits occur dependent upon the volume and rapidity of the current which carries the detritus to the valleys below. The generally received formula of analyses of rocks are approximate only, because of the imperfectness of science at the time they were made. Thus, phosphoric acid is not found to enter as a constituent in many of the analyses of the crystalline rocks, nor are we informed thereby of the presence of other substances which science is daily bringing to our notice. Professors Kirchhoff and Bunsen* remark: "In this way we arrive at the unexpected conclusion that lithium is most widely distributed throughout nature, occurring in almost all bodies. Lithium was easily detected in 40 cubic centimeters of the water of the Atlantic ocean. Ashes of marine plants, (kelp,) driven by the Gulf Stream on the Scotch coasts, contain evident traces of this metal. All the orthoclase and quartz from the granite of the Odenwald which we have examined contains lithium. A very pure spring water from the granite in Schlierbach was found to contain lithium. All the ashes of plants growing in the Odenwald, on a granite soil, as well as Russian and other potashes, contain lithium. Even in the ashes of tobacco, vine leaves, of the wood of the vine and of grapes, as well as in the ashes of the crops grown in the Rhine plain near Waghäusel, Deidesheim, and Heidelberg, on a non-granitic soil, was lithium found. The milk of the animals fed upon these crops also contains this widely diffused metal. In the manufactories of tartaric acid, the mother liquids contain so much lithium salts that considerable quantities can thus be prepared. Dr. Folwarczny has been able to detect lithium in the ashes of human blood and muscular tissue by spectrum observations." It appears, also, from observations made by those distinguished investigators, that all silicates contain potassium, and that lithium is scarcely ever absent from the tobacco ash. These are observations of singular and interesting import, and tend to prove how inadequate the re-agent and the crucible are in comparison with other methods which science is revealing. But little reliance can be placed upon knowledge entirely dependent upon chemical research. Who is able to tell us by analysis the composition of a soil, whether it is rich or poor, fertile or barren? "When we reflect," says an intelligent writer,† "that an acre of soil six inches deep may be computed to weigh about 1,344,000 lbs., (though the roots of plants take a much wider range than this,) and, taking the one constituent of ammonia or nitrogen as an illustration, that in adding to this quantity of soil a quantity of ammoniacal salt containing 100 lbs. of ammonia, which would be an unusually effective dressing, we should only increase the per-centage of ammonia in the soil by 0.0007, it is evident that our methods of analysis would be quite incompetent to appreciate the difference between the soil before and after the application; that is to say, in its state of exhaustion and highly productive condition so far as that constituent is concerned." It is not designed to undervalue the immense benefits conferred by chemistry upon civilization, nor to abate the high expectations that may be justly entertained with respect to its increasing usefulness; but when chemistry ceases to speak, we must not neglect the proffered aid of other handmaids. The science of chemical geology is of vast interest to the agriculturist; and the universal diffusion of the metal lithium throughout the older rocks and the soils derived from them, together with its constant presence in the ashes of tobacco, gives assurance of the advantages resulting from the most abstruse, profound, and minute investigations. Distinguished gentlemen tell us that, upon analyses by spectrum observations, the eye is able to detect with the greatest ease the salt of sodium in quantities less than $\frac{1}{3000000}$ of a milligramme, (a milligramme being $\frac{154}{10000}$ of a grain;) and of the salt of lithium, with absolute certainty, less than $\frac{9}{100000000}$ of a milligramme. The presence of $\frac{1}{1000}$ of a milligramme of the chlorate of potassium is also detected by this method; and by it every silicate has been found to contain potash. These statements should not excite our wonder in view of other improvements of the age. Had it been stated twenty years ago that we should in this era converse by electricity across the ocean, it would have seemed as incredible as the declaration at this time of our future ability to determine at least some of the inorganic constituents of the atmosphere of the stars.

The alterations of rocks have attracted the attention of all chemists conversant with geology. It is a subject of deep study and investigation, and has given rise to much discussion. All rocks are susceptible to the permeating effects of water, and its action has been continuous for incalculable time. The products of one alteration change by subsequent action, and each changed condition is again metamorphosed by the action of newly created products. The changes are never ceasing; and the results are as varied as they are unmitigated.

These reflections lead to an understanding of the vast powers of Nature's resources in preparing soils for new productions, and for the recuperation of those which, though not exhausted, have become inert. If metamorphism took place wholly by igneous action, decomposition would almost entirely cease on the cooling of the rock. It is not here

* See London, Edinburgh, and Dublin Philosophical Magazine for August, 1860, p. 97.
† Dr. Gilbert, of Rothansted, St. Albans, England.

intended to deny, however, that heat has performed an important work at various periods of the earth's history in effecting changes of rocks, the evidences of which are obvious to every student of the earth's structure.

Both of the constituents of granite, felspar, and mica, as has been stated, contain potash; and analyses are herein presented as types of these two mineral species so important in the constitution of the crystalline and altered rocks and their derivatives, whether stratified rocks of ulterior formation or soils from which organic nature derives its support and existence.

The term felspar includes minerals of different composition. Under the name orthoclase are the synonyms felspar, potash-felspar, ice-spar, felsite, adularia, murchisonite, leelite, amausite, amazon-stone, sunadin, moonstone, napoleonite, necronite, pegmatolite, mikroklin, valencianite, feldstein, eisspath, erythrite, and perthite—the last-named variety being generally termed potash-felspar to distinguish it from those varieties which contain little or no potash, that substance being substituted by soda, lime, and lithium.

Locality.	Silex.	Alumina.	Ox. iron.	Lime.	Potash.	Soda.	
Lomnitz	66. 75	17. 50	1. 75	1. 25	12. 00	-------	=98. 25, V. Rose.
Vesuvius	65. 52	19. 15	--------	0. 60	14. 74	-------	G. Rose.
Dransfeld	64. 86	21. 46	trace.	trace.	2. 62	10. 29	=99. 23, Schned.
Chamouni	66. 48	19. 06	trace.	0. 63	10. 52	2. 30	=98. 99, Delesse.
St. Gothard	65. 69	17. 97	--------	1. 34	13. 99	1. 01	=100.
Baveno	65. 72	18. 57	--------	0. 34	14. 02	1. 25	
Siberia	65. 32	17. 89	0. 30	0. 10	13. 05	2. 81	
Chili	65. 37	20. 47	--------	2. 60	6. 30	4. 00	
Ceylon	64. 00	19. 43	--------	0. 42	14. 81	-------	
Marienberg	66. 43	17. 03	0. 49	1. 03	13. 96	0. 91	
Saxony	65. 52	17. 61	0. 80	0. 94	12. 98	1. 70	
Valencianite	66. 82	17. 58	0. 09	------	14. 80	-------	
Microline	65. 76	18. 31	trace.	1. 20	13. 06	-------	
Perthite	66. 44	18. 35	1. 00	0. 67	6. 37	5. 56	
Lake Superior	66. 70	18. 68	--------	0. 30	9. 57	3. 58	
Davidson co., N. C.	65. 30	20. 20	trace.	0. 05	14. 35	0. 79	
Chesterlite	64. 76	17. 60	0. 50	0. 65	14. 18	1. 75	

This table of analyses will suffice to give the composition of different varieties from localities widely separated. It is not essential to describe each variety in detail in order to impart an understanding of the subject. For such description the intelligent farmer should consult approved works on mineralogy.

Mica is not only one of the constituents of granite, but it enters into the composition of gneiss, mica slate, sienite, and more recent rocks, such as sandstones, granular limestones, trachyte, and basalt. It is sometimes known as Russian glass, and has been used in vessels of war, as resisting the effects of explosions better than common glass. It is now extensively applied to the small doors of anthracite stoves, to lanterns, and for other purposes of utility. Fine specimens of it are found in New Hampshire, in plates sometimes a yard across and perfectly transparent.* Isinglass land is a term applied to soils formed by the decomposition of rocks containing mica.

ANALYSES OF MICA.

Locality.	Silex.	Alumina.	Ox. iron.	Manganese.	Magnesia.	Potash.
Uto	47. 50	37. 30	3. 20	0. 90	----------	9. 60
Broddbo	46. 10	31. 60	8. 65	1. 40	----------	8. 39
Fahlun	46. 22	24. 52	6. 04	----------	----------	8. 22
Unionville	46. 75	39. 20	--------	----------	1. 02	6. 56
Litchfield	44. 60	36. 23	1. 34	soda. 4. 10	----------	6. 20
Chester county	45. 50	34. 55	trace.	soda. 2. 35	----------	8. 10
Monroe, New York	----------	----------	--------	----------	----------	-------

* Dana's Mineralogy.

As already stated, granite is a mixture in varied proportions of felspar, quartz, and mica, the composition of the first and last named of which is given in the above analyses. Felspar is the most important ingredient, constituting from 30 to 40 per cent., and even more. Granite may be said to contain, as a mean, about 72 per cent. of silex, 15 of alumina, 7.5 of alkali, and 5.5 of lime, magnesia, and oxyd of iron.

In gneiss and mica-schists mica predominates, causing a laminated or slaty structure. In sienite the mica is replaced by hornblende, but in other respects it has a near resemblance to granite. Hornblende contains little or no potash.

Porphyry is a compact rock, containing crystals of felspar scattered through the felspathic base.

Trap or greenstone is a dark, greenish-brown rock, very compact, with a minute crystalline texture. When the variety of felspar called albite (containing soda instead of potash) replaces the potash-felspar, the rock is called diorite.

Trap has been confounded with basalt. It is somewhat similar in appearance, and consists of a base of felspar with the mineral called augite or pyroxene. This rock, though yielding potash, is not enriched by the addition of augite, which is poor in potash when compared with other minerals herein described. Varieties of basalt have produced as high as nine or ten per cent. of this alkali. The residuum of the decomposition of felspathic rocks and clays, after the lime and alkalies have been carried off in solution, is a compound called kaolin, and is used in China, Saxony, and France in the manufacture of porcelain. That from which the celebrated Sevres porcelain is made comes from Limoges, in France. This substance is not uncommon in the United States, and will probably, at some future time, displace the less pure material now used in the production of inferior manufactures.

Clays (silex and alumina) are employed in making bricks; and the fewer impurities they contain the better the bricks, the presence of lime being especially injurious. Bricks are usually red owing to the presence of the oxyd of iron, which, when in small quantities, (as is usually the case,) does not materially affect their quality.

Attempts have been made to extract potash from felspar and other mineral substances for use in manufactures and in agriculture, but thus far without decided economic advantages.

Richard A. Tilghman, of London, obtained a patent in 1847 for a process for manufacturing sulphate of potash by heating above redness a mixture of potash-felspar, lime, and the sulphate of lime, of barytes or of strontian; also, for the manufacture of muriate of potash by heating together a potash-felspar and the muriate of soda, lime, or iron to a temperature above the melting point of the muriate employed; and he also claims a patent for manufacturing the chromate of potash by heating to redness a felspar with lime, or its carbonate, and chrome ore. These substances should be pulverized as finely as possible, that their action upon each other may be complete. The richer the felspar is in potash the better.* For a felspar containing sixteen per cent. of potash, he grinds the materials to a fine powder, and mixes intimately two parts of felspar, one part of lime, or an equivalent of carbonate of lime, and one part of sulphate of lime. These materials are placed on the hearth of a reverberating furnace heated to a bright red, which is kept up for eight hours, when the mass thus calcined is withdrawn from the furnace and frequently lixiviated and evaporated.

The green sand mentioned in former pages occurs along our eastern coast, and has a large development in New Jersey and Delaware. It runs through the counties of Monmouth, Burlington, Gloucester, and Salem, in the former State, and has been used largely as a fertilizer. It is found by analysis to contain from seven to thirteen per cent. of potash, and is expected by some to become the principal source of the potash of commerce. Mr. Wurtz found that when to the ignited green sand, chlorid of calcium was added in sufficient quantity to form, upon the fusion of the latter, a pasty mass, the decomposition of the green sand was complete. The water combined with the green sand must be expelled by heat previous to the fusion with the chlorid of calcium. The mass, after fusion, falls to pieces in water, yielding to this solvent all the potash contained in the green sand, in the form of chloro-hydrate of potash. There is so great a difference with respect to solubility between the chloro-hydrate of potash and the chloro-hydrate of lime that the separation of these two salts presents no difficulty.

In the manufactories of soda-ash large quantities of chlorid of calcium (chloro-hydrate of lime) are formed, but have no market value. This mode, if found practicable on a large scale, would offer a market for one of the useless products in the manufacture of soda, and thus indirectly reduce the price of soda or the cost of manufacture of that substance.

The principal resources of potash derived from the mineral kingdom have now been given, and it is from that source that all others come. Many distinct minerals contain pot-

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* See Repertory of Patents, fifth series, vol. 10, 1847

ash; but, since they are found in comparatively small quantities, it is not necessary to describe them here. The efflorescences which occur upon certain slates, and which impregnate the waters percolating them, are sometimes lixiviated, or the mineral waters are collected and evaporated for the manufacture of alum, which is composed of sulphate of potash 18.4, sulphate of alumina 36.2, and water 45.4. But in the manufacture of alum at Whitby, in England, the alkali is added to the water containing the sulphate of alumina.

The source from which commercial potash is derived is almost exclusively the ashes of plants. The application of ashes to soil, as a fertilizer, has long been known to exercise a most powerful influence over the growth of plants; and though ashes from the burning of wood contain other substances of importance, much is due to the presence of potash. As it enters into the composition of some plants in greater proportion than of others, its utility is, of course, manifested in unequal degrees. But the consideration of this topic will be resumed hereafter in connexion with subjects more intimately relevant.

Nitrate of potash, known in commerce as saltpeter, is a compound of nitrogen, oxygen and potassium, or nitric acid and potash—53.45 of the former, 46.55 of the latter. Its specific gravity is about 1.96. It crystallizes in six-sided prisms, and frequently effloresces in hair-like filaments. When pure it is translucent, if not transparent; it has a cold, bitter taste, acts as a diuretic, and is largely used as an antiseptic in curing meats, in connexion with other substances. It is soluble in water, especially at a high temperature, and is insoluble in alcohol. It deflagrates when thrown upon ignited coal, and is extensively used in China and elsewhere in pyrotechny, and is one of the principal ingredients of gunpowder. Formerly much of it was consumed in the manufacture of sulphuric acid; but the introduction of nitrate of soda from South America has superseded it for this purpose. It is also employed in the manufacture of flint glass. It has been practically tested as a fertilizer; but its present high price prevents its general use for this object. It has been employed in solution for sprinkling grain, as a protection from insects, and in like manner for the preservation of wood from their attacks.

Saltpeter is not found deposited in veins or strata, like salt and nitrate of soda, so far as is known to the writer. It only occurs native as an efflorescence, mainly upon limestones, marls, chalk, and rocks, containing lime and potash, such as the felspathic rocks. The saline crust of caves in Kentucky and other parts of the United States; those of Germany, of France, of the East Indies, and of Ceylon, in Africa, are efflorescences forming from day to day, from which a portion only of the nitrate found in commerce is derived. The nitrate of potash, thus obtained, does not exist pure, but always combined with the nitrate of lime and magnesia. Formerly chemists were of opinion that nitric acid was generated by the decomposition of animal matters found in the rocks upon which the salt effloresced, and from substances derived from the excrements of animals frequenting caves. The writer has examined caves in calcareous rocks in the West, the resort of myriads of bats, where their feces had accumulated to a considerable depth; but in these localities the formation of nitre upon the walls was never recognized. It is true that the attention was not particularly directed to the point; yet had such been the case the attention would have been arrested by the fact.

Mr. John Davy and Mr. Longchamp have advanced the opinion that the presence of azotized matter is not necessary for the generation of nitric acid and nitrous salts; but that the oxygen and azote of the atmosphere, when condensed by capillarity, will combine in such proportions as to form nitric acid, through the agency of moisture and of neutralizing bases, such as lime, magnesia, potash, and soda. This opinion would appear to be maintained by the fact of the production of nitrates in soils remote from habitations, were it not for the presence of organisms, containing nitrogen in most soils, or in the atmosphere with which they are in contact. But the increased production of nitrates by the addition of animal or nitrogenous matter to calvareous earths is a significant fact in this connexion. Much, if not the greater part of the saltpeter used in France, is obtained from the rubbish of old buildings and the scrapings of cellars, which are lixiviated and treated according to the prescribed rules. During the revolution in that country these sources sufficed for the supply of all the nitre used in the manufacture of gunpowder, seven-twentieths of which, according to Dr. Ure, were furnished by the city of Paris alone.

It would appear that, besides the presence of the bases lime, magnesia and potash, a degree of humidity is essential; that the temperature must be favorable, the formation of nitrates being very feeble at or about the freezing point, and that sunlight is considered unfavorable. These facts are singularly in accordance with the conditions necessary to the recuperation of worn-out soils, and cannot fail to command the attention of the intelligent observer.

It should be borne in mind that no nitrate of potash can possibly be formed without the presence of humidity in the materials to be acted upon. But the whole subject is surrounded with difficulties. The natural nitre beds of Ceylon, twenty-two in number, according to John Davy, are caverns that have been increased by successive extractions of material. The

caves are in rock containing carbonate of lime, talc, and felspar, which, as has been mentioned, contains potash. The views elsewhere expressed by the writer upon the presence everywhere of organisms contailning nitrogen, and which give it off in a nascent state, would appear to be a satisfactory explanation of the production of nitrates in presence of the bases named above, and in this instance of that of potash, which occurs as a carbonate, having been formed from the decomposition of the silicate of potash by carbonic acid, derived either from the interior of the earth or from the atmosphere in which it is always present. But even after having fulfilled all the conditions recited as essential, the action may be less prompt than we had hoped, from the want of something unappreciated, and ignored or left out of consideration. In the operations of nature, the most apparently trifling incident may be of capital importance, for nothing has been created without an object. Proud man's existence depends upon so many minute, inappreciable, yet essential contingencies, that the destruction of one unvalued element may cause the destruction of the entire race and the entire fabric of animated nature. Yet when man, taught of God, may, as it were, breathe upon the matter of this earth, and, promoting life and motion, exercise an influence to extend to the remotest limits of the universe.

According to Bowles, there is enough nitrate of potash in Spain to supply all Europe to the end of time. The nitre beds of India and Egypt are remarkable for the quantity of this salt found in them. The earth in which it is ascertained that nitrate occurs is dug up to the depth of several inches, thrown upon platforms or into heaps, and then lixiviated. The solution is led into basins made in the ground, and left to evaporate by the heat of the sun, as salt water is evaporated at Key West and elsewhere for the manufacture of ordinary salt. When the solution has been concentrated by the heat of the sun the operation is terminated in boilers, whence it is conducted into receptacles in which it is allowed to crystallize. The nitrate of lime remains in the water, and if ashes or any salt of potash suited to the operation can be procured, by their addition the nitric acid of the lime may be united with the potash of the ashes, thus giving an additional quantity of nitrate of potash. The liquid is, of course, to be decanted or filtered, to remove the insoluble portion of the ashes that have been added.

According to Mr. John Davy, the earth containing the nitrate in the district of Tirhoot, in Bengal, has the following composition :

Nitrate of potash	8.3
Nitrate of lime	3.7
Sulphate of lime	0.8
Muriate of soda	0.2
Carbonate of lime, with a trace of magnesia	35.0
Residuum insoluble in water and nitric acid	40.0
Water, with a trace of vegetable matter	12.0
	100.0

The formation of artificial nitre beds and the extraction of saltpeter are operations intimately connected with fertilization, and throw important light upon the formation of nitre in the soil.*

* The following instructions have been given by the consulting committee of *poudres et salpetres* in France for the construction of their *nitrières artificielles.*—The permeability of the materials to the atmospherical air being found to be as indispensable as is the presence of a base to fix the nitric acid at the instant of its formation, the first measure is to select a light friable earth, containing as much carbonate of lime or old mortar-rubbish as possible; and to inter-stratify it with beds of dung, five or six inches thick, till a considerable heap be raised in the shape of a truncated pyramid, which should be placed under an open shed, and kept moist by watering it from time to time. When the whole appears to be decomposed into a kind of mould, it is to be spread under sheds in layers of from two to three feet thick; which are to be watered occasionally with urine and the drainings of dung-hills, taking care not to soak them too much, lest they should be rendered impermeable to the air, though they should be always damp enough to favor the absorption and mutual action of the atmospherical gases. Moist garden mould affords an example of the physical condition most favorable to nitre beds. The compost should be turned over, and well mixed with the spade once at least in every fortnight, and the sides of the shed should be partially closed; for although air be essential, wind is injurious, by carrying off the acid vapors, instead of allowing them to rest incumbent upon, and combine with, the bases. The chemical reaction is slow and successive, and can be made effective only by keeping the agents and materials in a state of quiescence. The whole process lasts two years; but since organic matters would yield in the lixiviation several soluble substances detrimental to the extraction of saltpeter, they must not be added during the operations of the latter six months; nor must anything except clear water be used for watering during this period; at the end of which the whole organic ingredients of the beds will be totally decomposed. Where dung is not sufficiently abundant for the above stratifications, a nitre bed should be formed in a stable with friable earth, covered with a layer of litter. After four months the litter is to be lifted off, the earth is to be turned over, then another layer of fresh earth, eight or nine inches thick, is to be placed over it, and a layer of the old and fresh litter over all. At the end of other four months this operation is to be repeated; and in the course of a year the whole is ready to be transferred into the regular nitre beds under a shed as above described. Such are the laborious and disagreeable processes practised by the peasants of Sweden, each of whom is

The Academy of Sciences of Paris, in the year 1770, offered a prize for the best treatise on the formation of artificial nitre beds. Fifty years after, in the year 1825, Gay Lussac published instructions which may be expressed in the following axioms :

"All the nitrogen necessary for the formation of nitric acid is yielded to it by animal matter ; and nitrate of potash is never generated from the air in substances adapted for its formation, without the co-operation of animal matter." All the observations of scientific investigators go to prove that the quantity of nitric acid formed is in proportion to the quantity of animal matters present in the mixture.

Berzelius detected nitrates in the well water of the city of Stockholm ; and Liebig has shown the presence of nitrates in the waters of twelve wells in the town of Giessen,* although they could not be detected in the waters of six wells separated 2,300 paces from the town. Animal matter in a state of decay and putrefaction existed abundantly in the soil in all the places where nitrates were found, and its nitrogen was converted into nitric acid wherever the conditions for this conversion were united. The nitrates, when applied to land, even in small quantities, have a manifestly energetic influence upon the growth of plants ; but when applied too profusely they destroy vegetation entirely, especially when the season is dry. There are certain plants, such as the salsolas, in which potash is found in quite large proportions. The action of the nitrate of potash—indeed of all the salts of potash—is so similar to that of soda, that all further remarks upon the fertilizing effects of the former may be postponed until soda and its salts shall be considered.

SODIUM.

The analogy between sodium and potassium, and between the salts of these two metals, is very striking. Neither the metal nor the oxyd of sodium is found pure, but always combined with some acidifying principle ; and, thus combined, it exerts a most important influence in nature's economy. As has been stated, potassium is widely diffused, as well as sodium ; but the latter is much more extensively developed, being a constant and principal constituent of the water of the ocean and of certain lakes. It also occurs in strata, in immense deposits, as at Wilitzcka, in Poland, and it forms saline incrustations over large districts of country. It is likewise one of the bases of some of the crystalline rocks, in which it is coincident with potassium. It forms one of the components of vegetable ashes, and is particularly abundant in marine plants, from which it is extracted, its preparation and application in the arts giving rise to fruitful industry.

Common table salt is the *muriate of soda,* and this, together with other salts, imparts the nauseating taste to the water of the ocean. It enters into a variety of daily domestic uses, and into the manufacture of glass ; it is also the basis of all hard soaps, and assists in the process of bleaching. The nitrate of soda, which is found so extensively in South America, has become, at a comparatively recent date, almost an adjunct to civilization. The waters of the mineral springs of our country, with few exceptions, contain this salt, and this accounts for the resort of animals to the "salt licks." Some of these localities are remarkable on account of the immense number of bones that whiten the face of the earth around, many of which are curious and interesting as the remains of extinct species of animals which, at a former, yet comparatively recent date, inhabited those regions, but are gone, never to return. Big-bone Lick, in Kentucky, is one of these localities. In travelling over the western expanse the attention of the writer has frequently been arrested by the depressions around mineral springs, worn down by the continued licking of the earth impregnated with saline substances by myriads of buffalo and other wild animals, which, with the aborigines themselves, have disappeared before that race of men which is destined to possess the earth.

The details already recited concerning potassium will facilitate the inquiry respecting sodium and its combinations. To Sir Humphrey Davy is due the honor of the discovery of sodium, which took place about the period of the discovery of potassium. Sodium is always a product of artificial chemical preparation, and has great analogy, chemically and physically, to potassium, the same mode of preparation being pursued for both. It is soft and

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bound by law to have a nitre bed, and to furnish a certain quantity of nitre to the State every year. His *nitriary* commonly consists of a small hut built of boards, with a bottom of rammed clay, covered by a wooden floor, upon which is spread a mixture of ordinary earth with calcareous sand or marl, and lixiviated wood ashes. This mixture is watered with stable urine, and its surface is turned over once a week in summer and once a fortnight in winter. In some countries walls, two or three feet thick, and six or seven high, are raised with the nitrifying compost, interspersed with weeds and branches of trees, in order at once to bind them together, and to favor the circulation of air. These walls are thatched with straw ; they are placed with one of their faces in the direction of the rains, and must be moistened with water not rich in animal matter. One side of the wall is upright and smooth, while the other is sloped or terraced, to favor the admission of humidity into their interior. The nitre eventually forms a copious efflorescence upon the smooth side, whence it may be easily scraped off.

* *Vide* Annals de Chimie et de Physique.

ductile, of the consistence of wax, has a silver gray color, and is lighter than water, its specific gravity being but 0.972. It is volatile only above the cherry-red heat, and decomposes water, but does not ignite the hydrogen, unless, as Mr. Serullus observes, the water is thickened by the addition of a substance like gum, which prevents the cooling of the metal, in which case the hydrogen is inflamed. When a piece of sodium is thrown upon mercury an amalgam is formed, and a production of heat and light takes place, which does not occur with potassium.

Oxyd of sodium is prepared much in the same manner as potash, by decarbonating the carbonate of soda with caustic or quicklime, decanting or filtering, and evaporating. It absorbs the humidity of the atmosphere with great avidity, deliquescing like potash, but by exposure to the air absorbing carbonic acid and efflorescing; while the carbonate of potash is as deliquescent as the caustic alkali

The *silicate of soda* is a constant constituent of certain varieties of felspar; and it is even doubted whether it is entirely absent from any combination where potassium occurs. The substance known to mineralogists as oligoclase, or soda felspar, (which name is a sufficient indication of its main characteristic,) has an immense development in forming granites, of which some of the most gigantic ranges of mountains are composed; and it is supposed that the saline efflorescences which occur on the plains of North America, east of the Rocky mountains, and east of the Andes, in South America, are due to the decomposition of the soda felspars, which, in the latter instance, give rise to the formations whence the nitrate of soda is procured for exportation. As a type, the variety called albite is composed of silica 68.7, alumina 19.5, soda 11.8, = 100. Specimens from one locality yield more soda than those from another. The distinctly characterized felspars, whether containing an excess of soda or of potash, with but few exceptions, yield the peculiar alkali; and those metamorphic rocks known as trap, basalt, petrosilex, obsidian, pitchstone, phonolite, pumice, and a variety of distinct minerals occurring in lavas, with few exceptions, yield one of the alkalies, and often both in varying proportions. But, although the subject is not irrelevant, restricted limits prohibit further detail at present. The mineral species—rock-salt, muriate of soda, common salt—occurs in all sedimentary rocks throughout the world, from the transition to the tertiary, and is generally associated with gypsum. In the United States there are many well-known localities in which this substance is found, and where salt is extracted from waters obtained by means of artesian or other wells. In Pennsylvania, on the Kanawha in Virginia, in Missouri, and elsewhere, large establishments have been provided for this business. Hydrochloric acid is formed whenever watery vapor, or steam, comes in contact with muriate of soda at a red heat. The muriate of soda and magnesia are found among the principal mineral constituents of sea water, and may easily pass in large quantities into volcanoes. Lavas contain silicate of potash and of soda, and, when acted upon by muriatic acid, these give rise to salts which effloresce upon the surface. Organic remains are rare in rock-salt; yet they do occur, not only in the mineral, but in salt water in the ocean and in isolated salt pools.

The general tendency of opinion favors the belief that rock-salt is a deposit from the water of the sea. Salt springs evidently originate from the contact of water with salt in those formations where the mineral salt occurs, in one form or another, in masses stratified or variously mixed with other minerals, and in which the salt may exist in small proportions, yet in very large amount, when the extent and development of the formation are considered. In either case, the continued action of water upon isolated masses, or upon formations through which salt may be disseminated, in the course of time forms vacant spaces into which the superincumbent masses settle down, when dislocations appear on the surface of the ground. These are among the thousand changes effected in the lapse of time by the continued action of atmospheric agents; and hence those superficial appearances in physical geography the causes of which can be appreciated in detail only as results.

When mineral waters are saturated with alkaline salts, a protracted contact with the mineral salt may be inferred, especially where the carbonate of soda occurs, the presence of which indicates that the water has been charged with carbonic acid which had remained in contact with or long continued action upon the rocks containing silicate of soda. In looking back, so to speak, through a vista of myriads of centuries, the most lively imagination is lost in the endeavor to appreciate effects that the slightest continuous cause might produce. In the course of time soils that were barren, and that would have continued so unaided by extraneous influences, have become fertile. Thus it is known, and from long continued analysis it is proved, that the atmosphere contains all the salts existing in sea water. The ocean becomes agitated; the spray rises and is divided, and is thus held in suspension; the salts are carried far inland to fertilize the soil by imperceptible, but constant, never-ending contributions.

Carbonate of soda, composed of 58.57 of soda and 41.43 of carbonic acid, crystallizes from a concentrated solution by cooling, and when exposed to the air effervesces. It does not decompose when exposed to the strongest heat, unless in contact with water. It is

found in combination with the sulphate of soda in different parts of the world. In the desert of Thiat, in Egypt, there is a lake which, during the rainy season, becomes filled with water charged with the carbonate and the sulphate of soda; and this carbonate is obtained separate from the sulphate. Sea weeds, such as salsola, salicornia, atriplex, statice, bates, and various species of fucus, contain soda, usually combined with vegetable acids. These plants, when burned—by which process the vegetable acids are converted into carbonic acid, which combines with the soda—by lixiviation give solutions containing carbonate, sulphate, and hyposulphite of soda; also sulphide, iodide, bromide, chloride, and corresponding salts of potassium; but the latter salts in small proportion. Other substances, such as muriate of soda, oxyd of iron, carbonate of lime, alumina, silex, and charcoal, also result, in varied but minor proportions, from the imperfect process of reducing these plants to ashes.

The barilla, or soda of Alicant, is obtained in Spain. In the environs of Malaga and Carthagena a variety of salsola is cultivated for the purpose of extracting the carbonate of soda. In the environs of Narbonne and of Frontignan, in France, the salicornia annua is cultivated for a like purpose, being sown and harvested in the same year; and the salicornea europea, the salsola tragus, and the salsola kali are all collected and burned for the production of the alkaline carbonate. Along the sea shore, in Normandy, vast quantities of these sea plants are collected, and here they yield a large proportion of sulphates of soda and potash. Iodine is obtained from the mother waters, called the waters of Wareck, after the extraction of these salts; and most of this substance found in commerce comes from that part of the world.* But by far the greater portion of commercial soda (carbonate of soda) is manufactured in the environs of Marseilles. An ardent sun gives an economical heat for the extraction of the muriate of soda by evaporation, and the carbonate of soda is extracted from that salt by the process of Mr. Leblanc. The muriate of soda is treated with sulphuric acid,† by which the muriatic acid is disengaged and the sulphate of soda formed. The muriatic acid may be collected, or suffered to escape; but it is now usually saved, and decomposed by a peculiar process, and the chlorine (muriatic acid being a compound of hydrogen and chlorine) is applied to the process of bleaching, which operation upon cotton and linen clothes formerly required weeks for its completion, with the risk of rotting the fiber by frequent sprinklings and exposure to the sun, but is now so expedited as to be effected in as many hours. The sulphate of soda, a compound of sulphuric acid and soda, is decomposed by submitting that salt to a proper heat, in contact with a certain quantity of carbonate of lime and charcoal. The residuum is lixiviated, evaporated, and crystallized.

Near the borders of the Mediterranean is the region of the olive, from which a large amount of oil is made. The two substances, oil and soda, being the product of the same locality, are employed in the manufacture of soap of a most excellent quality, and known throughout the world as Castile soap, from the fact of its having been first made in the province of Castile. The purest and best of this soap is the white; but that usually sold is marbled with the sulphate of iron or copperas, which soon becomes red, adding nothing to the real value of the soap, but rather proving its impurity, though preferred generally from habit or in compliance with fashion.

The amount of capital employed in the chain of operations to which this chemical discovery gave rise is now immense, and the business is not confined to France; for, at a period not very remote, Mr. Tenant, of Glasgow, in Scotland, from a simple workman became the possessor of a colossal fortune, and was honored as a benefactor to mankind, having by his genius provided employment for an entire population, his buildings alone covering at one time more than eight acres of ground, and embracing all the operations, from the manufacture of the sulphuric acid and the employment of the collateral products, to the final process of bleaching on a colossal scale. This is one of the striking illustrations of the effect of a single scientific scintillation. The residuums from such manufactories are frequently excellent fertilizers, and are employed as such with great advantage.

Sulphate of Soda.—This was discovered by Glauber, and is still known in the dispensatories as Glauber's salts. He described it after having investigated the residuum of the treatment of common salt (muriate of soda) by sulphuric acid, a compound which was thought useless, and which received the names of "caput mortuum," "damned earth," &c. The sulphate of soda is without color, and has a peculiar bitter taste, very disagreeable, as all those know who have used it as a purgative, for which it is employed, though less frequently than formerly. It is fusible below red heat, and crystallizes in long six-sided prisms. When exposed to the air, it gives off its water of crystallization, effloresces, and finally falls into a white

* The carbonate of soda, as well as that of potassium, is found in the serum of the blood of animals. It is somewhat doubtful, however, whether the soda of the blood is combined with carbonic or other acids, such as phosphoric.

† Sulphur is extracted for the manufacture of the acid in the near Island of Sicily.

powder. It is one of the constant constituents of sea water, and is also found in certain spring waters, and in the water of the artesian well of Louisville, Kentucky. This remarkable well, the depth of which is 2,086 feet, throws up 330,000 gallons of water in twenty-four hours, which is ejected to a height of 170 feet above the surface of the earth. This water is perfectly limpid, with an unvarying temperature of 76½° all the year round. Its specific gravity is 1.0113. The solid contents left on evaporating one wine gallon to dryness are 915½ grains, furnishing on analysis the following substances:

	Grains.
Chloride of Sodium (common salt)	621.5204
Calcium	65.7287
Magnesium	14.7757
Potassium	4.2216
Aluminum	1.2119
Lithium	0.1064
Sulphate of Soda	73.2957
Lime	29.4342
Magnesia	77.3382
Alumina	1.8012
Potash	3.2248
Bi-carbonate of Soda	2.7264
Lime	5.9915
Magnesia	2.7558
Iron	0.3518
Phosphate of Soda	1.5415
Iodide of Magnesium	0.3547
Bromide of Magnesium	0.4659
Silica	0.8857
Organic matter	0.7082
Loss	8.1231
	915.4634

The gases in one gallon are:

	Grains.
Sulphuretted hydrogen	2.0050
Carbonic acid	6.1720
Nitrogen	1.3580

This analysis was made by J. Lawrence Smith. Its results resemble those given by the Kissingen waters of Bavaria, and are analogous to those of the Blue Lick water in Kentucky. The analysis of this water reveals to us the important fact that there is scarcely a single constituent that is not a fertilizer, or a component part of plants and animals. It has been shown that lithium is found in the ashes of all tobacco, to which plant it may be essential. It is contained in the artesian well water of Louisville.

If the products of the earth are so wonderfully increased by irrigation with waters that are comparatively pure, what might not be the results obtained from applying the water of such wells. It is not known to the writer that artesian wells have been sunk for the application to agricultural improvement of waters holding in solution inorganic substances; nor that the particular adaptation of this water to that use has attracted the attention of agriculturists. The suggestion now made may hence have important results hereafter. The height to which this water rises above the level of the ground indicates a force that may be made available in giving it an application which the flow from an ordinary spring would not offer in many localities.

If it is true that substances are created once and forever, and are exhausted or carried off by cultivation, then they must be replaced, or there can be no vegetable growth; and the application of such waters to the particular localities where they flow naturally, or may be brought to the surface, as in the instance cited, will have the effect of fixing civilization upon such localities for so long a time as they continue to flow or shall be applied. Upon exhausted lands or desert wastes, or where vegetation has not been sufficient to support life, such ingredients may, by these artificial or artesian wells, be brought to the surface and made to adapt the lands for homes for millions of the human family—turning upon the soil a running current of wealth, the value of which can only be estimated by that of life itself, since life cannot exist without it.

By reference to the foregoing analysis, it will be observed that the water contains not only the inorganic constituents of organic life, but, with the carbonic acid and sulphuretted

hydrogen gases, there is nitrogen, an important material essential to life, and in such a state of combination as to fit it for assimilation. If the nitrogen be in a nascent state, it is eminently adapted, and if simply in combination with water, it is doubtless sufficient. How it is combined in the present case, the analyst does not state. The quantity of muriate of soda can scarcely be considered a disadvantage, as that substance may be extracted for economical uses, leaving the mother water still adapted to use as a fertilizer.

Sulphate of soda is obtained from certain mineral waters by evaporation and subsequent crystallization, and from the mother liquors from which common salt has been extracted. As has been stated, it is produced in large quantities by treating common salt with sulphuric acid. The chlorohydric acid is driven off and the sulphuric acid combines with the soda, and may be separated by evaporation. It is composed of 43.82 of soda and 56.18 of sulphuric acid.

Nitrate of Soda.—This is composed of nitric acid 63.5 and soda 36.5. A substance imported from Chili, and extensively employed in the arts, is composed of nitrate of soda, chloride of soda, sulphate of potash, nitrate of potash, and nitrate of magnesia, with impurities consisting of a mixture of the soil whence it is taken. This salt, sometimes called cubic peter, is found in the district of Tarapaca, in North Chili, where it occurs on a dry plain, at an elevation of 3,300 feet above the sea. For a distance of forty leagues the ground is covered to a depth of several feet with beds of this salt, which occurs with sulphate of lime, sulphate of soda, and chlorohydrate of the same base. The shells which occur in this formation are recent, and similar to those existing in the ocean. The nitrate of soda is found in distinct strata, a thin layer of brown loam separating the parts. It is also found mixed with salt, and forming a small portion of the entire mass. It goes through a very defective process of refining; it is then dissolved in water, evaporated, crystallized, and packed in bags, and is thus sent to the coast on the backs of mules. The wood used in its preparation is also transported from a distance on the backs of mules.*

SILICIUM.

Berzelius discovered in 1823 the mode of preparing pure silicium, and described the history and properties of many compounds containing that metal, previous to which time their precise nature was unknown, or at least very imperfectly understood. It forms part of the greater number of minerals of which we have knowledge, and next oxygen appears to be the most abundantly diffused of the simple substances. It is found combined with oxygen, in a pure state, as rock crystal, or mixed with oxyd of iron and divers other substances, or in combination with various bases, as already described.

Silicium. when pure, is not characterized by a metallic lustre, but appears as a dark-brown powder, in this respect not differing from other bases, as zirconium is without the usual characteristics of metals; hence the doubt that has arisen among some chemists in relation to the propriety of classing this substance among the metals.

When silicium is heated with the hydrate of potash or soda to the melting point of either of these alkalies, an explosion takes place, attended by vivid incandescence and the emission of hydrogen gas, which becomes ignited by combining with the oxygen of the air and the re-formation of water. It is infusible before the blow-pipe.

The oxyd of silicium, silica, silicic acid, quartz-crystal, when submitted to the heat of an oxy-hydrogen blow-pipe, melts, and may be drawn into long threads like glass. If thrown into water when in a fused state, it solidifies into a transparent mass, very hard, yet tough and not easily broken, even when struck with a hammer. Steel is thus hardened by being plunged into water when heated. It is volatilized when heated with the vapor of water, and is deposited like snow. It is tasteless and inodorous; and, though it combines with bases and forms silicates, it is without action upon vegetable colors. When precipitated from potash or soda, with which it may have been combined as a silicate of either alkali, it may be re-dissolved in muriatic acid. In this instance it most probably bears the relation of a base. When the solution of silica in hydrochloric acid is evaporated without carrying the operation to the expulsion of all the water, the silica forms a pellucid jelly, and this becomes completely insoluble on evaporation to dryness. Silex thus prepared is a white powder, insoluble in acids or caustic alkali until again brought in contact with potash and soda. All the salts of silicic acid are insoluble in water, except those of potash, soda, and lithia.

At a certain distance toward the centre of the earth all matter is doubtless in a fused condition. Silica forms part of the rocks of a crystallized character which occur around this molten mass. It is either amorphous, crystalline, or combined with several bases, such as alumina, potash, soda, &c., and as such is known under the mineralogical name of

* B. H. Blake, Silliman's Journal, vol. 39, 1840

felspar, already described in some detail. It occurs in all the metamorphic rocks, and has an immense extension, as developed in the red sandstone formation; it forms nodules, called flint, in the chalk deposits, and is one of the constituents of sedimentary deposits in different parts of the world. It enters, also, into the composition of all glass, and in slags from furnaces in which iron, copper, &c., are manufactured.

Ordinary glass is a mixture of silicate of potash or soda with other silicates, such as those with a base of lime, magnesia, oxyd of iron, manganese, lead, &c.; and, when in plates, appears to resist the action of water, but in the course of time becomes opaque, and is finally decomposed. Specimens of glass taken from ancient tombs show such decomposition, and, when pulverized and treated with water, portions are dissolved. The silicates with several bases, or double silicates, are more fusible than the simple; and those with many bases are affected by water in the proportion of their soluble base, such as potash and soda. Glass in which the oxyd of lead enters to a large extent is more fusible than other descriptions, all glasses being silicates, and differing only in the proportions and nature of their bases. The same may be remarked of potteries. The white porcelain is free from impurities, particularly such as impart color. The tinting of glass and porcelain is produced by the addition of metallic oxyds, and has little or no effect upon the material itself.

Mortars are silicates. Hydraulic mortars owe their properties of becoming hard under water to a mixture of silicates, such as silicate of alumina. A limestone containing from 25 to 30 per cent. of such insoluble residuum, when calcined as for making quicklime, will give a cement which will harden under water in about twenty-four hours. Hydraulic limestones may be prepared artificially by making the proper mixtures.

Flint, agate, chalcedony, cornelian, opal, jasper, amethyst, &c., consist almost entirely of silica, colored by different oxyds of metals; cornelian, by oxyd of iron; amethyst, by oxyd of manganese; and it is said that peculiar opalescent appearance characteristic of the mineral called opal is owing to minute fissures inhabited by microscopic organisms. Whatever may be the coloring matter from which the silex derives its shade, the amount thereof is sometimes scarcely appreciable to analyses.

In the vegetable kingdom silica is a constant ingredient of plants, as is shown by analyses of the ashes. In some it occurs more largely than in others, the grasses appearing to contain more than other plants, particular varieties, such as the arundinaria, possessing quite large amounts. Varieties of reed contain at times crystallized silica, and will often strike fire with steel. The epidermis contains so much of this substance that the edge of a knife used in cutting the stalk of the plant soon becomes blunted.

"Silica, under soluble conditions, is a comparatively large ingredient in the food of agricultural plants, and plays an important part in the fertility of soils. The quantity of it in any one species of plant varies in different parts of the plant, in different varieties of the species, and upon different kinds of soil. The quantity of it, in the mean of six specimens of turnip bulbs, analyzed by Professor Way and Mr. Ogston, amounted to 0.34 lb. per ton; in the mean of six specimens of turnip-tops, to 1.73 lb. per ton; in the mean of six specimens of entire crops of turnips, to 0.55 lb. per ton; in the mean of three-specimens of beet-bulbs, to 0.54 lb. per ton; in the mean of three specimens of beet-leaf, to 0.76 lb. per ton; in the mean of three specimens of entire crops of beet, to 0.56 lb. per ton; in the mean of five specimens of carrot-roots, to 0.24 lb. per ton; in the mean of three specimens of carrot-leaves, to 4.46 lbs. per ton; in the mean of three specimens of entire crops of carrots, to 1.22 lb. per ton. The quantity of silica, according to the same authority, amounts to 0.61 lb. per ton in the tubers of Jerusalem artichoke, to 1.76 per ton in peas grown on chalk, to 0.84 lb. per ton in peas grown on clay, to 2.53 lbs. per ton in pea-straw grown on chalk, to 5.04 lbs. per ton in the entire crop of peas grown on clay, to 1.94 lb. per ton in pea-straw grown on clay, to 0.42 lb. per ton in beans grown on clay, to 2.61 lbs. per ton in bean-straw grown on clay, to 3.17 lbs. per ton in the entire crop of beans grown on clay, to 60.0 lbs. per ton in wheat-straw, to 172.1875 lbs. per ton in wheat-chaff, and to 16⅗ oz. in every 28 bushels, or 1,792 lbs. of wheat grain. Two important practical inferences from these facts are, that the root crops bring up soluble silica from the deep parts of the soil, or assist the subjugation of crystalline silica under soluble condition in the higher parts of the soil, in preparation for the uses of the corn crops, and that by far the major portion of all the soluble silica abstracted from the soil by a whole course of crops may be returned to it in the leaves or tops of the root crops, and especially in the straw and chaff of the grain crops. A main office which silica appears to perform is to give mechanical firmness and strength and resistiveness to the parts and organs of plants which are most exposed to the risk of fracture or prostration, or other injury from the weather; and therefore it is scarcest in the pulp or farina of seeds and in the flesh of succulent roots, less scarce in leaves, more abundant in culms, and most plentiful in the sheltering chaff-coats of the ripening grain.

"The quantity of soluble silica in most soils, or of silica under conditions which render it capable of solution, and readily available for the use of plants, is so great as to render special applications of it altogether unnecessary. The small proportion of it, too, which is

carried off by the seeds of field crops, and not returned in the portions of farm-yard manure which consist of leaves and culms and chaff, is, in general, far more than compensated by the disintegration of part of the insoluble silicious constituents of the soil in the operations of fallowing and tillage, and by the bringing up of soluble silica from the lower parts of the soil in the absorptive process of root crops, and allowing it to remain on the field by carrying away only their bulbs, or tubers, or taps. 'Between corn corps,' as Liebig suggests, 'we may grow mangel-wurzel, or even potatoes, if we remove only the tubers of the latter, and allow the plant itself, which contains much silica, to remain on the field.' But, in fact, most fields contain such a large natural store of available silica that no care respecting it needs to be entertained, and no expedient for any special supply of it needs to be adopted, for centuries to come. Almost the only soils, or at least the chief ones, which may now and statedly require direct applications of it, are peat lands and other predominantly humous grounds, which contain a comparatively small proportion of mineral matter, and which produce such soft and flexuous corn-culms as want sufficient strength and firmness to resist the buffetings of the weather. Yet many scientific farmers, and even some distinguished agricultural chemists, contend that artificial silicates should be applied to all soils; that they form an indispensable ingredient in any compound special manure which is intended to serve as a substitute for farm-yard manure; and that they form a fit and sometimes necessary preparation for a wheat crop on any land which has suffered an appreciable abstraction of its soluble silica by the crops of the immediately preceding years. The question thus brought into dispute is one of very considerable practical importance, and requires much knowledge and very comprehensive thought for its proper investigation."*

ALUMINUM.

This metal is of recent acquisition to the arts. It is interesting because of its properties, but, above all, as an object toward which the attention of men of science has been turned for half a century. Philosophical research had developed a knowledge of its properties before its separation or production, now confirmed by this achievement. The contest of many years was between the natural difficulties obstructing the investigations relating to an unknown substance, on one side, and all the efforts of science, as then comprehended, on the other. The difficulties presented, for a time, baffled and set at defiance these efforts. But theory, as a beacon, lighted the way, and practice finally triumphed. History will record this vindication of the supremacy of science, and the trophy will continue in the keeping of civilization forever.

Aluminum resembles tin and silver, but, when hammered, has a somewhat bluish appearance. It is malleable almost without limit, and can be beaten into foil or drawn into wire without reheating. It is more tenacious than silver, and perhaps less so than copper. It is about as hard as virgin silver, but is easily cut with a knife. It is very sonorous, the sound produced by a blow upon a bar of the metal resembling that of glass. Many experiments have led to the belief that it is the best known conductor of sound. The density of this metal when cast is 2.56; when laminated 2.67. It fuses at a higher temperature than zinc, and lower than silver, and crystallizes on cooling. When pure it is unalterable by air or water. The hydrate of potash or of soda has a powerful action, evolving hydrogen, and, in the solution, an aluminate of the alkali. It forms alloys with silicium, iron, zinc, nickel, tin, bismuth, copper, gold, &c.†

ALUMINA.

Alumina, or alumine, is one of the component parts of alum, from which it was first extracted. It is the principal constituent of clays, in which it is found generally mixed with other substances that impart to it a color, it being naturally white. It is a compound of oxygen and the metal aluminum just described. The precious stones, corundum, sapphire, emery, and other varieties, are nearly pure crystallized alumina, particularly the sapphire, which is very hard, and is cut by means of diamond powder and polished on lead wheels with the same powder, or that of emery, a less pure variety of the same mineral. The specific gravity of alumina is 2. (water being unity.) It is without smell, and has little or no taste, but is not altogether void of astringency. It has a strong affinity for water, and gives it off with readiness when heated. The tenacious, sticky nature of clay soils is owing to this property, and is marked in proportion as the soil approaches to pure alumina. As it gives off water under the effects of the sun or the wind, it hardens, cracks, and becomes obdurate and unyielding. Of all soils pure clay is therefore the most difficult

* Wilson's Cyclopedia, vol. IV., p. 218; article, Silica.

† Deville and Wöhler on Aluminum.

to manage or subdue by cultivation. Sir Arthur Young has said that "no man ever throve upon a stiff soil." Strong teams are required to work it, and this can be done at the proper moment only, as it is not only difficult and expensive, but to a certain extent injurious at other times. Clay has merits which should not be underrated, such as the retention of fertilizers more effectually perhaps than any other material, and its capability of absorbing ammonia when exposed to the air, as is apparent to the smell when a piece of clay is breathed upon, for the peculiar odor emitted on such an occasion is due to the presence of this alkali.

Alumina is rather an essential element of soils, or purveyor of food, than a constituent of plants; for the ashes of plants rarely contain it, and even then but sparingly. There is reason to suppose that those analyses which give alumina as a constituent in certain plants are erroneous, and that what was rendered as alumina may have been in reality phosphate of lime. Thus, it is stated that three-fifths of a grain of alumina are found in thirty-two ounces of the grains of wheat, and about four grains in thirty ounces of the grains of barley and of oats. It is also said to constitute 3.72 parts in 100 of the entire plant of the sunflower, 7.11 of the entire plant of Turkey wheat, and 14 of the entire plant of the fumitory. It is seldom or never found uncombined, but rather in the form of silicate, sulphate, or phosphate of alumina. It is found to be an important part of the crystalline rocks, as has been noted under the head of silicates and in relation to the composition of felspars.

Aluminous minerals, so manifestly essential to the fertility of soils, are extensively diffused throughout the surface of the globe. They occur in all soils susceptible of cultivation, which may be owing to the fact that they are retentive of fertilizing salts; and, according to a paper lately published by Professor Voelcher, aluminous earths possess the power of absorbing and retaining fertilizing principles in such a state of combination as to readily yield them to plants, without their being subject to detraction from that combination by rain or water as it usually falls or passes through soils. "In order to form a distinct conception of the quantities of alkalies in aluminous minerals," says Liebeg, "it must be remembered that felspar contains 17¾ per cent. of potash, albite (soda felspar) 11.43 per cent. of soda, and mica from 3 to 5 per cent.; and that zeolite contains from 13 to 16 per cent. of alkalies. The analyses of Gmelin, Lowe, Fricke, Meyer, and Redtenbacher have also shown that basalt and clinkstone contain from ¾ to 3 per cent. of potash, and from 5 to 7 per cent. of soda; that claystone contains from 2.75 to 3.31 per cent. of potash; and loam from 1½ to 4 per cent. of potash." The quantities of these substances present in any specimen cannot give a correct estimate of its presence in all portions of any rock; nor are the alkalies the only fertilizers to be anticipated, where analysis has not heretofore mentioned or detected their presence, since the presence of phosphoric acid has been shown in a variety of rocks which were considered free from that substance and from all organic remains, such as clinkstone, phonolites, hornblende, augite, compact basalt, trap rock, pumice stones, obsidian, mica, granite, chlorite-slate, porphyry, mica-slate, and gneiss, and in native borax from the East Indies.

Soils eminently aluminous, as has been stated, are absorbents of water and retentive thereof. This renders them stiff, waxy, and cold, as well as damp, and exceedingly difficult to cultivate and subdue. It has been said that this property of clay soils may be modified by the application of sand; but this is often expensive, at all times laborious and attended with difficulty in making the admixture. The cohesive nature of clays may be overcome, and they made comparatively porous, dry, warm, and fertile, by the operation of paring and burning, the particles being thus partly fused and made to cohere and form a gritty mass containing the elements inherent to the clay with the properties of sand. Besides this, burnt clays have an increased power for the absorption of ammonia; but clays thus altered by heat lose a great proportion of their retentiveness of moisture. The most cohesive clays may by this process be converted into a fine dry, powdery soil as light as an ash bank; and where rushes, and coarse grasses, and semi-aquatic plants have obtained, a new growth will come in, and the soil will become fertile and easily cultivated. The roots and fibers of weeds and plants, and all noxious seeds, may be eradicated by paring and burning; and in a vast number of instances soils of a clayey nature that cannot otherwise be brought into economical culture, may by this operation be rendered fruitful. The alteration in the inert vegetable fiber existing in soils, when subjected to this operation, will often have a decided effect upon its productiveness by converting useless and injurious matter into assimilable plant food; or a product may be thus obtained having an advantageous chemical action upon the inorganic constituents of the soil. The transformation of inert vegetable fiber by charring, or even roasting, will add to the absorbent quality of the soil in proportion to the amount of those substances in the earth; for it is known that charcoal has surprising qualities of absorption and condensation, not of water, but of those gases which have an evident influence upon fertillity. The paring and burning process, though applicable and advantageous to deep clays that are barren from their closeness and their wetness, would be followed by disastrous consequences if applied to shallow arenaceous lands. In this case it would drive off or destroy even the scanty vegetable matter that such a soil might contain, leaving

an arid sandy waste. Sandy soils are frequently too porous, and the heat generated by paring and burning could not give consistence to such a material as silicious sand, since silex, however fusible when in contact with bases such as alumina, lime, magnesia and the alkalies, is refractory by itself.

Rough old pastures having a basis of clay, when infested with moss or noxious insects, or which possess a thick coarse turf susceptible of combustion by itself, or with the addition of brush, coal, ashes, &c., may be benefitted by paring and burning. Peat, weeds and moss are, in some situations, burned for their ashes; and if the soil with which they are to be mixed contains lime it is no disadvantage, shells, marl and sea sand containing, calcareous matter of any kind, being a desirable addition to the ashes thus produced. The charred clay of burning sod, or even old crumbling bricks, is a manure particularly adapted to some soils, in certain cases being preferred to lime, and appearing to be well suited to kill the moss in old swards. A thin, mossy clay soil will certainly be benefitted by paring and burning; and perhaps the most economical method of reclaiming such soils is to plow them up with a portion of the subsoil and then burn them. This may be done by setting fire to heaps, with or without the addition of other combustible than the vegetable matter existing in the roots of fibers of the plants growing upon the soil. The more luxuriant the moss or weeds growing upon such a soil the more clay can be mixed in the heap, and the richer the ashes that are thus produced.

The growths on salt marshes, together with the surface soil, when pared and burned, will be found rich in saline matter, such as soda and lime, and will prove a valuable addition either to the soil whence they are taken or to others upon which they may be placed. Many soils in our country which have been mismanaged, neglected and suffered to grow up in luxuriant unprofitableness, may be greatly benefitted by paring and burning. It would appear from experiments made to determine the comparative advantages derived from turning in such lands and paring and burning them, that the advantages are decidedly in favor of the latter process. "The one method," remarks an able agricultural writer, "opens an immediate source of great profit, whereas the other leads to nothing but disappointment and expense."

OXYD OF IRON AND MANGANESE.

Little need be said in this place of these two substances, since, though they exist abundantly in nature, and in most, if not all, cultivated soils, it is supposed their presence in plants is accidental, and always in small quantities. The protoxyd of iron is strongly disposed to pass to a further degree of oxydation; and wherever it occurs, as in some subsoils, to this tendency has been attributed the fact that the oxygen of rain water is not given up to the roots of plants, but absorbed by this oxyd. Drainage or subsoiling, by giving greater porosity to the soil, would facilitate aeration, and do away with the supposed unhealthy effect of the protoxyd of iron. As the oxyd of iron is known to occur in animal bodies, there is reason to suppose that its presence is essential to certain plants. Soils containing ferruginous matter are not benefitted by the addition of organic or putrid animal manures. The peroxyd of iron is reduced to the state of protoxyd by the action of the organic matter which unites with a portion of the oxygen in the peroxyd. Where the sulphuret of iron is found, a chemical action may be brought about by the addition of lime.* The peroxyd of iron absorbs and retains ammonia, and imparts it to plants as they require nitrogen, which is known to be a constituent of that gas and of organic matter.

Experiments made on oats by the Prince Sabin Horstmâr, of Brunswick, to test the necessity of inorganic constituents, prove that plants of the higher orders cannot develop themselves nor ripen their seeds unless such substances are present. In speaking of iron, it is stated that this base being absent, and all others present, the plant was very pale, weak and disproportioned; without manganese it did not attain perfect development, and bore but few flowers. According to the researches of this gentleman, chlorine appears to be essential to the growth of wheat; and, in combination with sodium, as has been stated, is a constant portion of the atmosphere, being wafted from the ocean, where it rises with the spray.

When added to soils in which it does not exist, or exists in inadequate quantities, the oxyd of manganese has the effect of changing the normal color of flowers. Thus the flowers of the hydrangea may be made to turn from pink to purple.

Some of the leading facts connected with the history of the mineral substances essential to the production and continuance of animal and vegetable life have now been presented. In the economy of vegetable life the mineral food necessary both for vegetables and animals is prepared, and without this previous preparation there could be no animal life. These

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* See Agricultural Report for 1859, pp. 152, 154.

inorganic constituents all come from the soil, and the soil is derived from the rocks. They are essentials, however limited; and though all may not be necessary for the production of one plant, the absence of one requisite element forbids that production. Of such materials, and such only, must the multifarious natural and artificial mineral fertilizers be composed. If they are not in the soil they must be added, or all progress in agriculture will be at an end, and population, so far as it is dependent upon the products of the soil, will disappear. The air we breathe has no value in a commercial sense, yet it is essential to life; and so may we speak of many other natural gifts unlimited in supply. We are apt to look upon the constituents of the soil in this light; but without going far back into history, or leaving our own continent, there are melancholy proofs of the contrary; and nothing is hazarded in saying that if the present system of culture shall be continued in the South, the time is fixed when there will be scarcely a single acre of upland under cultivation. The production of the great staple which now vivifies the commerce of the world will be restricted to the alluvions and the marl formations, and the same result must follow wherever a similar mode is pursued.

Thus much having been said of the elementary principles on which all agriculture depends, it may be well to adduce examples of the composition of the inorganic portions of plants. The analyses of the ashes of different plants, and of different parts of plants, are taken from the pages of Morton's Cyclopædia of Agriculture. From these tables the intelligent agriculturist will be able to draw many useful and interesting conclusions, showing how such investigations may be made subservient to economical production.

Table showing the composition of the Ashes of Wheat, according to recent analyses.

Plants, or parts of plants.	Ashes in 100 parts of crop, as taken from ground.	Ashes in dry plants, when all the water is artificially removed.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Wheat of foreign growth—															
Grain, red	......	......	21.87	15.75	9.60	1.93	49.32	0.17	.....	1.96	....	....	Giessen	Will & Fresenius	
Grain, white	......	......	33.84	......	13.54	3.09	49.21	.....	.....	0.31	....	....	do	do	
Do	......	......	25.90	0.44	6.27	1.92	60.39	.....	3.37	1.33	....	....	Leipsic	Schmidt.	
Do.	......	......	6.43	27.79	12.98	3.91	46.14	0.27	0.42	0.50	....	....	Holland	Bichon	This wheat being grown near the sea, part of the potash is substituted by soda.
Do	.....	......	24.17	10.34	13.57	3.01	45.53	.....	1.91	0.52	....	....	Sols. Hesse-Cassel.	Thon	
Do	......	.....	30.12	.....	16.26	3.00	48.30	1.01	1.31	....	....	....	Beechelbronn & Alsace.	Boussingault.	
Do	1.55	1.74	32.39	2.32	13.94	3.47	43.47	0.35	3.05	0.97	....	....	France	Way & Ogden	
Do	1.50	1.68	30.30	1.00	14.28	3.17	45.80	.....	4.48	0.89	....	....	Odessa	do	
Do	1.7	1.88	35.77	9.06	14.09	2.05	34.44	0.24	4.00	....	....	....	Adrianople	do	
Do	1.97	2.19	36.60	0.53	11.12	4.34	41.03	0.18	4.97	1.18	....	....	Egypt	do	
Hopetoun wheat, grown in England—															
Grain, white	1.81	2.05	33.15	......	12.71	3.20	47.00	0.24	2.84	0.60	....	....	Cirencester	do	Grown on calcareous stone brash on the oolite.
Do	1.51	1.69	33.00	2.07	13.99	2.82	46.18	0.48	1.42	....	....	....	do	do	Grown on calcareous brash and clay.
Do	1.48	1.70	27.06	4.08	13.57	4.29	41.22	1.91	5.91	1.36	....	....	do	do	The seed from which the two previous specimens were grown.
Do	1.56	1.72	32.24	4.06	10.94	2.06	45.73	0.32	2.28	2.04	0.27	....	Dorset	do	Loamy soil, on the clay below the chalk.
Do	1.63	1.84	29.92	6.08	12.43	1.83	45.30	0.59	4.43	1.76	0.64	....	do	do	Calcareous soil.

Table showing the composition of the Ashes of Wheat, according to recent analyses—Continued.

Plants, or parts of plants.	Ashes in 100 parts of crop, as taken from ground.	Ashes in dry plants, when all the water is artificially removed.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Hopetoun wheat, grown in England—															
Grain, white	1.61	1.81	36.43	4.62	13.26	1.32	39.97	0.15	4.23	....	....	....	Gloucestershire.	Way & Ogden	Silicious soil lying on limestone.
Do	1.63	1.81	32.05	3.38	9.32	4.43	47.33	.....	3.05	0.35	....	....	do	do	Clayey soil on the Silurian rocks.
Do	1.71	1.94	34.51	1.87	11.69	1.80	43.98	0.21	5.63	0.29	....	....	do	do	Sandy soil on the Silurian rocks.
Do	1.69	1.92	30.32	0.07	12.38	2.51	49.22	0.18	3.60	0.08	1.60	....	do	do	Clayey soil on the Silurian rocks.
Do	1.76	2.01	32.14	2.14	9.67	8.21	44.44	.....	3.29	0.08	....	....	do	do	Sandy soil on old red sandstone.
Red-straw white wheat, grown in England—															
Grain, white	1.70	1.91	31.00	2.54	9.53	1.45	40.91	0.08	9.71	3.34	0.34	....	Sutton; Waldron.	do	Loamy soil on the greensand.
Do	1.72	1.95	29.75	0.64	13.75	3.27	49.58	0.60	2.14	0.23	....	....	Gloucestershire.	do	Sandy loam on the old red sandstone.
Do	1.73	1.97	29.91	1.87	14.05	3.39	47.44	.....	2.63	0.67	....	....	do	do	Do. do.
Do	1.61	1.81	30.13	1.25	11.46	6.87	47.38	0.07	2.76	0.07	....	....	do	do	Calcareous soil on the mountain lime stone.
Do	1.60	1.80	30.02	3.82	13.39	1.15	46.79	.....	3.89	0.91	....	....	do	do	Clayey loam on Ludlow rock (?)
Do	1.90	2.13	29.17	2.20	14.22	5.05	46.61	0.44	2.17	0.09	....	....	do	do	Sandy calcareous soil—Silurian.
Do	1.73	1.96	26.70	2.12	12.76	6.78	46.99	0.24	2.05	2.32	....	....	do	do	Calcareous clay on magnesian limestone.
Old red Lammas wheat	1.84	2.10	34.26	4.53	6.56	3.21	40.57	0.32	5.46	2.06	....	....	Wantage	do	Very calcareous soil on the chalk.
Spalding wheat.	1.81	2.05	29.76	5.26	11.06	2.88	48.21	0.11	2.23	0.23	....	....	Cirencester	do	Calcareous stone brash; great oolite.
Creeping wheat.	1.73	1.95	31.18	2.42	12.35	1.50	46.49	0.61	5.20	0.22	....	....	Hackness	do	Soil, clayey sand.
Do	1.65	1.85	28.89	1.40	13.06	6.76	45.64	1.55	2.55	0.11	....	....	do	do	Do.
Do	1.71	1.91	30.94	1.28	12.74	3.72	48.53	.....	1.34	1.40	....	....	do	do	Soil, calcareous rubble, Oxford clay.
Mean of the 32 analyses	1.67	1.93	29.97	3.90	12.30	3.40	46.00	0.33	3.35	0.79	0.09	....			

Wheat straw	......	......	15.32	......	2.45	4.58	2.92	10.59	60.58	1.56	1.56	....	Scotland?	Fromberg	In this analysis the number in the 11th column refers to chlorine only.
Do	7.00	......	9.56	0.31	5.19	8.83	3.22	1.04	70.19	1.04	0.62	....	France	Boussingault	Do. do.
Do......(creeping)	4.60	5.22	10.31	0.13	1.56	7.46	6.62	3.95	69.66	0.28	....	....	Hackness	Way & Ogden	The chaff, which contained 13.05 of ash, is included in this analysis.
Do..........do	4.30	4.94	12.48	0.25	1.43	4.94	8.54	2.33	69.94	0.06	....	....	......do......	......do......	The chaff, which contained 16.54, ditto.
Do......(Hopetoun)	4.07	4.61	11.79	......	1.45	6.96	5.24	4.45	69.36	0.73	....	....	Whitfield	......do......	The chaff, which contained 11.77, ditto.
Do..........do	4.16	4.82	10 03	0.85	3.27	4.44	7.05	5.59	67.1	1.54	....	....	......do......	......do......	The chaff, which contained 10.36, ditto.
Do......(red-straw)	4 68	5.30	12.76	0.68	3.29	3.53	5.77	3.31	70.50	0.14	....	....	......do......	......do......	The chaff, which contained 13.78, ditto.
Do..........do	2.74	3.12	9.47	1.39	3.53	7.34	3.37	2.28	71.49	1.11	....	....	......do......	......do......	The chaff, which contained 7.04, ditto.
Do..........do	4.20	4.79	17.98	2.47	1.94	7.42	2.75	3.09	63.89	0.45	....	....	......do......	......do......	The chaff was not included.
Do......(red-straw wheat)	4.95	5.60	11.76	......	3.62	6.82	8.85	2.23	66.13	0.54	....	....	......do......	......do......	Chaff included; ash contained in it, 9.63.
Mean of 10 analyses	5.10	3.84	12.14	0.60	2.74	6.23	5.43	3.88	67.88	0.74	0.22	....	....	....	

Table showing the composition of the Ashes of Barley, Oats, Rye, Maize, Rice, Millet, and Buckwheat, according to recent analyses.

Plants, or parts of plants.	Ashes in 100 parts in crop as taken from the ground.	Ashes in artificially dried plants.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Barley, grain, and straw...............	......	7.15	13.86	......	3.96	11.81	7.67	4.37	37.27	2.30	1.84	......	Oxford	Daubeny	Grown in Botanic Garden of Oxford—soil recently manured.
Barley, grain of......................	2.04	......	19.1	......	7.6	3.6	31.2	3.4	33.2	2.30	2.3	......	Ensham	......do	Soil on Oxford clay.
Do	2.37	......	3.91	16.79	10.05	3.36	40.63	0.26	21.99	1.93	......	......	Cleres.........	Bichon............	
Do	......	......	20.91	......	6.91	1.67	38.48	......	29.10	2.10	......	......	Leipsic........	Schmidt...........	
Do...... (without husk).........	2.5	......	29.50	......	15.90	2.90	47.0	1.00	1.30	......	......	......	France	Boussingault	
Do	3.05	......	16.00	8.86	4.30	3.23	36.80	0.16	29.67	0.83	......	......	Scotland	Thomson..........	
Do	2.70	......	13.75	6.75	8.60	2.21	39.80	0.17	27.65	1.07	......	......	Neufchatel	Kochlin	
Do . ...(?)	1.90	......	21.1	1.3	7.2	4.5	27.7	2.4	34.0	2.44	......	......	Essex	Daubeny	
Do	2.14	2.43	21.14	......	7.26	1.65	28.53	1.91	30.68	2.13	1.01	5.65	Dorset?	Way and Ogden ...	Calcareous soil.
Do...... (Chevalier)...........	2.25	2.50	20.77	4.56	7.45	1.48	31.69	0.79	32.73	0.51	......	......	....	......do.	
Do...... (Moldavian)...........	2.12	2.43	31.55	1.06	10.17	1.21	28.64	0.27	24.56	1.02	1.47	......	....	......do.	
Mean of 10 analyses of barley grain....	2.34	2.43	19.77	3.93	8.55	2.58	35.20	1.03	26.49	1.43	0.47	......	....	....	
Barley straw..................	4.9	......	21.6	0.7	5.7	6.1	4.9	0.8	48.9	4.26	11.2	......	Essex	Daubeny	
Do	4.2	......	24.40	1.06	1.70	9.65	1.80	4.60	47.20	4.74	8.25	......	Ensham	......do.	
Do	7.00	......	9.20	0.30	5.00	8.50	3.10	1.00	67.60	1.00	1.4	......	France	Boussingault	
Mean of 3 analyses of barley straw....	5.36	......	18.40	0.68	4.13	8.08	3.26	2.13	54.56	3.33	6.95	......	....	....	
Barley aulm	13.7	......	1.30	0.24	0.99	5.00	1.30	0.90	89.5	......	0.80	......	Ensham	Daubeny	
Do...... (Chevalier)	12.10	14.23	7.70	0.36	1.23	10.36	1.99	2.99	70.77	1.46	1.10	......	....	Way and Ogden...	
Mean of 2 analyses of barley aulm....	12.90	14.23	4.50	0.30	1.12	7.68	1.64	1.94	80.13	0.73	0.95	......	....	....	
Oats, grain	......	......	12.3	......	7.7	3.7	14.9	1.0	53.3	1.3	......	1.0	Alsace	Boussingault	
Do...... (Hopetoun)	2.27	2.50	17.80	3.84	7.33	3.54	26.46	1.10	38.48	0.49	0.92	......	Dorset.........	Way and Ogden...	Calcareous soil.

Do......(Potato)	2.45	2.73	19.70	1.35	8.25	1.31	18.87	0.10	50.93	0.27	0.07			......do.	
Do......(Poland)	2.65	2.97	24.30	5.51	8.26	2.65	14.49	1.74	41.86	0.69	0.45			......do.	
Do......(Poland)	3.31	3.80	16.35	5.27	5.90	8.35	16.19	4.01	43.20	0.09				......do.	Grown from the grain of previous sample.
Do	2.75	3.12	13.97	1.50	8.82	4.22	21.53	0.13	49.44	0.36			Cirencester	......do.	
Do	4.00		12.90		7.70	3.70	14.90	1.00	53.30	1.30			France	Boussingault	
Do......(Potato,) [without husk]	2.22		21.22		11.26	6.69	38.48	18.36	3.60				Scotland	Norton	
Do......(Hopetoun)....do	2.14		31.15		8.64	5.21	49.19	2.54	1.73	0.80			....do	......do.	
Mean of 7 analyses of oats' grain	2.90	3.02	16.76	2.49	7.70	3.92	18.19	1.29	47.08	0.64	0.20	0.14			
Mean of 2 analyses of oats without husk	2.18		26.18		9.95	5.95	43.84	10.45	2.67	0.40					
Oat husks	6.49		6.99		1.01	4.31	2.65	5.01	74.73	1.61			Scotland	Fromberg	Grown on mossy land.
Do	7.22		5.66		0.64	2.05	1.80	4.90	81.72	1.80			....do	......do.	
Do......(Hopetoun)	6.46		7.39		0.38	1.95	1.04	11.61	73.85	1.58			Northumberland	Norton	
Do......(Potato)	6.99		12.47		2.35	4.30	0.66	4.30	74.28	0.32					
Mean of 4 analyses of oat husks	6.79		8.13		1.09	3.15	1.54	6.46	76.16	1.33					
Oat straw			12.18	13.01	4.58	7.29	1.94	2.15	54.25	1.41	2.48		Giessen, Hesse-Darmstadt.	Levi	
Do	5.10		26.09	4.69	2.98	8.84	3.19	4.37	42.60	2.24	cl.5.0		Alsace	Boussingault	
Mean of 2 analyses of oat straw	5.10		19.14	9.69	3.78	8.07	*2.56	3.26	48.42	1.83					
Oat chaff, (Hopetoun)		16.53	7.96		1.84	4.53	5.84	5.32	68.04	0.24	5.11			Norton	
Do	7.84	9.22	13.12	4.06	2.58	8.65	6.26	2.48	59.92	1.42	1.24		Cirencester	Way and Ogden	
Mean of 2 analyses of oat chaff		12.87	12.57		2.21	6.59	*6.26	3.90	63.98	0.83	3.17				
Oat leaf, (Hopetoun)		8.44	14.89		2.55	6.99	6.13	14.80	51.65		2.29			Norton	
Rye grain	1.36	1.60	33.83	0.39	12.81	2.61	39.92	0.17	9.22	1.04			Kidderminster	Way and Ogden	
Do			32.76	4.45	10.13	2.92	47.29	1.46	0.17	0.82			Giessen	Will and Fresenius	
Do			11.43	18.89	10.57	7.05	51.81	0.51	0.69	1.90			Cleres	Bichon	This probably has soda substituted for potash from growing near the sea.
Mean of 3 analyses of rye grain	1.36	1.60	26.00	7.91	11.17	4.19	46.34	0.71	3.36	1.25					
Rye straw			17.19		2.41	9.06	3.82	0.83	64.50	1.36	0.57	0.26	Giessen	Will and Fresenius.	
Maize (Indian corn) grain			26.63	7.54	15.44	1.59	39.65	5.54	2.09	0.60			U. States	Fromberg	
Do..........do			30.8		17.0	1.3	50.1		0.8				Bechelbronn	Letellier	
Mean of 2 analyses of maize grain			32.48		16.22	1.44	44.87	2.77	1.44	0.30					

* Phosphates.

Table showing the composition of the Ashes of Barley, Oats, Rye, Maize, Rice, Millet, and Buckwheat—Continued.

Plants, or parts of plants.	Ashes in 100 parts in crop as taken from the ground.	Ashes in artificially dried plants.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Maize straw	2.30	......	14.46	39.92	1.84	4.93	11.76	1.01	18 89	0.90	6.29	.....	Styria	Hruschauer	
Do	6 50	......	4.78	12.69	11.44	11.00	22.39	1.37	35.05	0.73	0.55	......	....do.....	......do.	
Mean of 2 analyses of maize straw	4.40	......	9.62	26.30	6.64	7.97	17.08	1.19	26.97	0.81	3 42	......	....	....	
Rice grain	......	1.00	18.48	10.67	11.69	1.27	53.36	......	3.35	0.45	......	.....	....	Johnston	
Rice husk	......	14.18	1.60	1.58	1.96	1.01	1.86	0.92	89.71	0.54	......	......	....	......do.	
Rice straw	......	12.97	10.27	3.82	4.49	0.73	1.09	3.56	74.09	0.67	......	......	....	......do.	
Millet grain	......	......	9.58	1.31	7.66	0.86	18.19	0.35	59.63	0.63	1.43	......	Giessen	Rolich	
Buckwheat grain	......	......	8.74	20.10	10.38	6.66	50.07	2.16	0.69	1.05	......	......	Cleres	Bichon	Grown near sea, and probably, therefore, contains less potash and more soda than usual.

Table showing the composition of the Ashes of Beans, Peas, Lentils, Vetches, Hemp, and Flax.

Plants, or their parts.	Ash in 100 parts.	Ash in artificially dried plant.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Field bean, Vicia faba	4.00	......	20 82	19.06	8 87	7.26	37.94	1.34	2.46	1.03	2.45	......	Holland	Bichon	
Do	......	......	46.20	......	8.98	5.33	35.67	1.66	0.51	......	......	1.49	Alsace	Boussingault	
Do	......	......	32.74	12.75	6.13	4.72	39.11	......	0.47	0.66	......	......	Giessen	Buchnes	
Mean of 3 analyses of field bean	4.00	......	33.25	10.60	7.99	5.77	37.57	1.00	1.14	0.56	0.81	0.49			
Field bean, (whole plant)	6.45	......	36.1	......	3.20	20.3	9.25	3.50	2.90	2.33	3.17	1.08	Oxford	Daubeny	
Do	5.7	......	23.20	0 24	4.28	38.20	4.32	2.80	4.48	3.77	1.38	......	....do.	....do.	
Do	4.4	......	14.20	7.80	4.06	40.0	3.68	2.19	4.50	4.24	1.12	......	....do.	....do.	
Mean of 3 analyses of field bean	5.51	......	24.50	2.68	3.84	32.83	5.75	2.83	3.96	3.44	1.89	0.36			
Haricot bean, (Phaseolus vulgaris)	......	......	21.71	21.07	7.35	5.38	35.33	2.28	1.48	0.34	3.32	......	Hesse-Cassel	Thon	
Do	......	......	51.23	......	12.03	6.07	28.53	1.36	1.05	......	......	0.21	Alsace	Boussingault	
Do	3.29	......	38.89	11.41	9.03	5.90	31.34	2.47	0.44	0.11	0.54	......	Giessen	Levi	
Mean of 3 analyses of haricot bean	3.29	......	37.27	10.82	9.47	5.78	31.73	2.03	0.99	0.15	1.28	0.07			
Field bean straw	......	......	53.08	1.60	6.69	19.99	7.24	1.09	7.05	0.22	4.26	......	Germany	Sprengel	
Peas, (field)	......	......	39.51	3.98	6.43	5.91	34.50	4.91	......	1.05	3.71	......	Giessen	Will and Fresenius.	
Do	3.00	......	34.19	12.86	8.60	2.46	34.57	3.56	0.25	0.96	0.51	......	Holland	Bichon	
Do	......	......	35.20	10.32	6.91	2.70	34.01	4.28	0.29	1.94	2.56	......	Hesse-Cassel	Thon	
Do	......	......	36.31	1.30	12.24	10.39	31.00	4.84	1.54	......	1.87	......	Alsace	Boussingault	
Mean of 4 analyses of field pea	3.00	......	36.30	7.11	8.54	5.36	33.52	4.39	0.52	0.98	2.16	......			
Field pea straw	......	......	4.73	......	6.88	54.91	4.83	6.77	20.03	0.40	......	......	Germany	Sprengel	
Lentils	2.06	......	27.84	6.65	1.98	5.07	29.07	......	1.07	1.61	6.13	......	Giessen	Levi	
Vetch	2.40	......	30.57	9.56	8.49	4.79	38.08	4.10	2.01	0.75	2.00	......	....do.	....do	
Vetch straw	......	......	35.49	1.02	6.36	38.33	5.49	2.39	8.66	0.17	2.75	......	Germany	Sprengel	

Table showing the composition of the Ashes of Beans, Peas, Lentils, Vetches, Hemp, and Flax—Continued.

Plants, or their parts.	Ash in 100 parts.	Ash in artificially dried plant.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Hempseed	5.60	......	21.67	0.66	1.00	26.71	34.96	0.10	14.04	0.77	0.09	......	Giessen	Leuchtweiss	
Hemp, whole plant	6.1	......	15.08	1.08	8.43	37.40	6.00	2.60	6.13	2.78	1.89	......	Oxford	Daubeny	Carbonic acid, 21.79.
Do	7.01	......	8.55	0.16	5.95	44.60	6.50	0.83	9.95	3.78	0.72	......	....do.	....do.	Carbonic acid, 23.00.
Do	6.0	......	8.62	0.07	2.62	47.60	5.35	1.20	10.00	3.94	0.47	......	....do.	....do.	Carbonic acid, 23.50.
Do	......	4.54	7.48	0.72	4.88	42.05	3.22	1.10	6.75	0.37	2.57	......	Ireland	Kane	Carbonic acid, 31.90.
Mean of 4 analyses of hemp, whole plant	6.37	4.54	9.93	0.50	5.47	42.91	5.26	1.28	8.20	2.71	1.41	......	......	......	
Linseed	4.63	......	25.85	0.71	0.22	25.98	40.11	0.99	0.92	3.67	1.55	......	Giessen	Leuchtweiss	
Do	......	......	17.59	6.92	14.83	8.46	36.42	2.47	10.58	1.25	0.30	......	Riga	Johnston	
Do	......	......	30.01	1.88	14.52	8.12	37.64	2.16	5.66	0.68	0.5	......	Holland	....do.	
Flax, (entire plant)	......	......	9.78	9.82	7.79	12.33	10.84	2.65	21.35	6.08	6.0	......	Ireland	Kane	Carbonic acid, 16.95.
(coarse)	4.24	......	7.70	19.18	3.44	15.38	11.20	6.28	3.05	4.50	8.21	......	Heesterl, Belgium.	....do.	Carbonic acid, 20.60.
(best)	5.44	......	22.90	......	3.33	16.48	11.80	6.17	3.41	1.52	8.70	......	Escamaffles, Belgium.	....do.	Carbonic acid, 25.23.
(best)	3.67	......	22.30	14.11	3.93	18.52	8.81	6.83	2.68	1.10	4.58	......	Hamme Zog, Belgium.	....do.	Carbonic acid, 16.38.
(coarse)	4.54	......	25.79	0.42	3.65	19.08	10.98	12.09	3.03	2.28	12.75	......	Belgium	....do.	Carbonic acid, 9.89.
Flax, (entire plant)	5.15	......	18.41	10.91	3.02	18.37	11.06	9.67	5.33	2.36	5.65	......	Holland	....do.	Carbonic acid, 13.75.
Do	10.7	......	26.50	......	4.76	22.30	8.40	6.20	2.16	3.42	2.93	7.35	Oxford	Daubeny	Carbonic acid, 19.10.
Do	8.0	......	25.8	1.3	5.9	27.0	8.5	5.3	2.3	5.41	2.0	......	....do.	....do.	Carbonic acid, 21.9.
Do	6.67	......	13.0	6.9	5.5	40.0	7.3	3.7	7.3	8.01	1.4	......	....do.	....do.	Carbonic acid, 14.4.
Mean of 9 analyses of flax	6.05	......	19.13	6.96	4.59	21.05	9.87	6.54	5.62	3.85	5.80	0.81	......	......	

Table showing the composition of the Ashes of Turnips, Beet, Mangel Wurzel, Carrots, Jerusalem Artichokes, Potatoes, and Cabbage.

Plants, or their parts.	Ash in 100 parts.	Ash in artificially dried plant.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Turnips, (bulbs)	......	7.60	41.96	5.09	5.34	13.60	7.58	13.60	7.95	1.28	6.0	....	France.....	Boussingault...	
Do	......	5.66	37.69	16.62	4.02	11.91	5.80	12.70	6.15	0.50	6.3	....	....	Muspratt	
Do	......	......	42.40	......	4.10	12.81	13.70	11.80	2.87	2.80	10.40	....	Oxford	Daubeny.......	Carbonic acid, 10.40.
Do	......	......	42.0	... ..	5.60	11.3	11.80	10.30	3.60	3.81	....	5.90	....do.	......do.	Do. 9.40.
Do	......	3.18	37.4	3.1	3.8	13.6	14.9	8.5	4.5	?	5.7	....	....do.	......do.	Do. 8.3.
Do........Skirving's Swede	0.75	......	23.70	14.75	3.28	11.82	9.31	16.13	2.69	0.47	7.05	....	Dorset	Way and Ogden	Do. 10.74.
Do................do	0.76	......	26.88	13.31	3.27	14.33	10.17	15.53	1.73	0.61	13.31	....	....do.	......do.	Do. 11.96.
Do........Dale's hybrid	1.09	......	36.93	8.01	2.51	6.46	8.77	11.71	2.75	0.14	10.0	....	....do.	......do.	Do. 12.66.
Do..............do..............	0.72	......	32.29	6.71	1.93	8.87	10.71	11.22	1.12	0.63	14.3	....	....do.	......do.	Do. 12.05.
Do...... Green top, white......	0.59	......	48.56	......	2.26	6.73	7.65	12.86	0.96	0.66	5.44	....	....do.	......do.	Do. 14.82.
Mean of 10 analyses of turnip bulbs....	0.78	5.48	36.98	6.76	3.61	11.14	9.74	12.43	3.43	1.09	7.85	0.59	....	....	In this analysis the carbonic acid seems to have been abstracted and the result calculated after the deduction.
Turnip tops	......	17.0	28.65	5.41	3.09	23.27	9.29	12.52	0.86	0.86	cl. 16.05	....	....	Johnston	Carbonic acid 9.98. This is the mean of analyses of six varieties.
Do	......	......	15.21	2.84	2.81	28.49	6.17	8.43	3.99	1.68	15.30	5.04	....	Way and Ogden	
Beet and mangel wurzel, (yellow globe).	1.02	......	23.54	19.08	1.75	1.78	4.49	3.68	2.22	0.74	24.54	....	....	......do.	Carbonic acid 18.14.
Do..............(long red).....	0.64	......	21.68	3.13	1.79	1.90	1.65	3.14	1.40	0.52	49.51	....	....	......do.	Do. 15.23.
Do................do.........	1.00	......	29.05	19.05	2.79	2.17	3.11	3.31	4.11	0.56	14.18	....	....	......do.	Do. 21.61.
Do	......	6.30	48.93	7.53	5.32	8.78	7.53	2.01	10.04	3.14	10.0	....	....	......do.	
Mean of 4 analyses of beet bulbs	0 88	6.30	30.80	12.19	2.91	3.65	4.19	3.03	4.44	1.24	24.55	....	....	....	
Beet tops	1.37	......	21.26	7.01	8.66	8.65	5.15	5.80	1.99	0.96	33.96	....	....	Way and Ogden	Carbonic acid 6.49.

Table showing the composition of the Ashes of Turnips, &c.—Continued.

Plants, or their parts.	Ash in 100 parts.	Ash in artificially dried plant.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Carrot roots, (white Belgian)	0.91	6.6	32.44	13.52	3.96	8.83	8.55	6.55	1.19	1.10	6.50	....	....	Way and Ogden	Carbonic acid 17.30; mean of five samples 17.82.
Do.....(white top)	4.12	18.2	7.12	10.97	2.92	32.64	1.67	6.20	4.56	2.40	13.67	....	....	......do.	Carbonic acid.
Jerusalem artichoke, (tuber)	......	6.00	54.67	......	2.21	2.82	13.27	2.70	15.97	6.39	3.3	....	France.....	Boussingault...	Carbonic acid being deducted.
Potato, (tuber)	......	4.00	59.95	......	6.28	2.09	13.16	8.27	6.52	0.59	5.20	....	....do.	......do.	
Do	......	4.01	57.58	3.66	4.53	0.81	9.98	14.63	3.68	0.42	8.6	....	Lanark....	Fromberg......	
Do	......	3.75	49.73	1.93	5.03	3.31	14.58	18.04	2.49	0.56	7.5	....	Drummore.	......do.	
Do	1.27	......	46.60	......	8.70	4.54	13.30	4.66	1.95	3.30	3.43	....	Oxford	Daubeny.......	Carbonic acid 13.30.
Do	1.08	......	50.00	0.84	6.85	2.70	16.20	2.37	7.15	5.15	1.95	....	....do.	......do.	Do. 11.90.
Do	0.76	......	43.80	......	12.65	3.10	11.15	6.0	6.67	6.85	2.30	7.60	....do.	......do.	Do. 6.70.
Mean of analyses of potato tuber, carbonic acid being deducted.	......	3.92	55.75	1.86	5.28	2.07	12.57	13.64	4.23	0.52	7.1	....	....	....	The vegetable acids are by incineration converted into carbonic acid.
Mean of analyses of potato tubers, as obtained by incineration.	1.03	......	46.80	0.28	9.40	3.44	13.55	4.34	5.25	5.1	2.56	2.5	....	....	
Potato top	......	14.96	28.02	16.26	7.09	16.96	7.62	6.88	3.85	1.05	cl. 12.33	....	....	....	
Cabbage leaves	......	22.0	11.70	20.42	5.94	20.97	12.37	21.48	0.75	0.60	cl. 5.77	....	....	....	

Table showing the composition of the Ashes of Grasses, Tobacco, Hops, Vegetables, Forest and Fruit Trees, and various Marine and Land Weeds.

Names of plants, or of their parts.	Ash in 100 parts.	Ash in plant, artificially dried.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
White mustard (seed)	4.15	......	9.80	9.18	11.00	20.81	36.60	5.29	3.29	1.43	0.33	......	Giessen	James	
Black mustard (seed)	4.31	......	12.01	4.63	13.64	16.47	35.46	6.79	2.63	1.06	2.15	.....	....do	....do	
Madia (Madia sativa) seed	......	......	9.53	11.24	15.42	7.74	54.99	......	......	1.08	......	.....	....do	Souchay	
Rye-grass seed	6.85	......	4.97	1.43	5.51	19.24	19.59	3.24	43.85	2.17	......	......	Scotland	Thomson	
Meadow hay	......	6.0	18.11	1.35	6.75	22.95	5 97	2.70	37.89	1.69	4.3	......	France	Boussingault	
Do	......	6.2	29.03	2.44	8.82	16.36	5.63	3 08	31.03	0.64	5.0	......	....do		
Do	......	8.66	30.09	......	4.08	9 12	12.03	3.79	24.17	1.55	5.70	......	Giessen	Fleetmann	
Do	...	11.40	9.71	15.60	......	7.30	15.79	3.02	26.06	2.23	20 46	......	....do	....do	
Mean of 4 analyses of meadow hay	......	8.06	21.73	4.85	4.91	13.93	9.85	3.15	29.77	1.52	8.86	......			
Lucerne	......	9.55	14.03	6.44	3.64	50.57	13.68	4.23	3.46	0.63	cl. 3.3	......	Germany	Sprengel	
Red clover	......	11.17	16.10	40.71	8.28	21.91	4.12	1.06	2.60	0.46	4.73	......	....do	Horsford	
Clover	......	7.7	35 47	0.67	8.40	32.80	8.40	3.33	7.06	0.40	5.8	......	France	Boussingault	
Rye-grass	......	5.89	8.03	2.17	4.01	6.50	12.51	......	64.57	0.36	......	......	Scotland	Thomson	
Common reed, (Arundo phragmites)	1.62	......	4.80	......	0.24	6.06	31.19	5.49	78.91	0.93	0.3	......	....do	Fromberg	
Esparsette, or Sainfoin	......	......	6.75	20.33	8.57	31.01	26.10	1.68	1.10	2.28	2.18	......	Besan	Buch	
Asparagus	......	......	28.07	3.96	4.44	18.04	13.74	7.84	13.69	5.78	cl. 4.4	......	....do	Levi	
Sugar cane, (stalks)	......	......	32.93	......	3.93	2.34	7.37	7.97	17.64	......	17.12	10.07	Demerara	Stenhouse	
Sugar cane, (whole plant)	......	......	16.03	0.35	16.24	10.10	6.14	8.30	44.17	......	3.76	4.91	Trinidad	....do	
Do.........do	......	......	14.20	1.18	3.51	5.12	6.53	7.22	47.20	......	5.04	......	Berbice	....do	
Do....young and transparent	......	......	9.56	0.27	5.51	12.21	7.98	3.53	51.84	......	3.47	5.63	Jamaica	....do	
Tobacco leaf	......	......	29.08	2.26	7 22	30.35	2.74	3.75	......	6.04	0.91	......	Debreczyn		
Do	......	......	30 67	......	8.57	27.12	1.88	3.27	......	4.15	5.95	......	....do		
Do	......	......	27.88	......	7.31	33.84	1.99	3.75	......	4.40	9.34	4.90	....do		

Table showing the composition of the Ashes of Grasses, &c.—Continued.

Names of plants, or of their parts.	Ash in 100 parts.	Ash in plant, artificially dried.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Tobacco leaf	......	......	18.20	......	15.73	32.06	2.12	5.91	......	4.68	11.41	3.92	Barat	......	
Do	......	......	8.20	......	13.93	46.08	1.90	4.65	......	4.17	3.22	8.53	Funfkirchen	Will & Fresenius.	
Do	......	......	19 55	0.27	11.07	48.68	3.66	3.29	......	2.99	3.54	......	....do	Will & Fresenius.	
Do	......	......	9.68	......	14.58	52.06	1.62	3.90	......	3.57	4.61	4.44	....do	Will & Fresenius.	
Do	......	......	9.36	......	15.59	52.00	2.10	3.58	......	4.62	3.20	3.27	....do	Will & Fresenius.	
Do	......	......	10.37	......	15.04	43.45	2.36	5.50	......	5.20	6.39	2.99	....do	Will & Fresenius.	
Do	......	......	11.21	......	12.77	49.16	1 97	2.98	......	4.33	2.58	2.97	....do	Will & Fresenius.	
Mean of 10 analyses of tobacco	......	......	17.42	0.25	12.18	41.80	2.23	4.06	......	4.41	5.11	3.10	....do	Will & Fresenius.	
Hops	......	......	19.41	0.70	5.34	14.15	14.64	8.28	17.88	2.71	3.0	......	England	Watts	Carbonic acid, 11.01.
Hops, (whole plant)	......	9.87	25.18	......	5.77	15.98	12.13	5.41	21.50	5.12	7.24	1.67	....do	Nesbit	
(leaves)	......	13.6	14.95	0.39	2.39	49.67	3.52	5.04	12.14	2.41	9.49	......	....do	Nesbit	
(bine)	......	3.74	24.35	......	4.10	38.73	6.92	3.44	6.07	0.28	6.47	6.94	....do	Nesbit	
Vine	[illegible]	......	34.13	7.59	6.55	30.28	16.35	2.66	1.45	0.16	0.83	......	Styria	Hruschauer	
Vine	3.25	......	24.93	7.00	8 79	35.94	19.55	2.35	0.62	0.24	0.58	......	....do	Hruschauer	
Vine	2.85	......	37.48	1.33	1.05	43.88	9.20	3.61	0.72	1.08	1.61	......	Misnia	Crasso	
Vine	2.83	......	17.55	26.76	9.17	30.33	2.85	2.01	1.61	6.63	3.05	......	Worms	Levi	
Vine	2.69	......	25.31	2.14	7.48	40.87	17.94	2.88	......	2.49	0.87	......	Weinsheim	Levi	
Mean of 5 analyses of vine	2.62	......	27.88	8.96	6.61	36.26	13.18	2.70	0.88	2.12	1.39	......	......	......	
Apple tree (Pyrus malus) wood	......	......	19.24	0.45	7.46	63.60	4.90	0.93	1.31	1.65	0.45	......	Giessen	Will & Fresenius.	
Cherry tree (Cerasis communis) wood	0.28	......	20.78	8.40	9.19	28.69	7.73	3.29	2.06	0.07	......	......	....do	Engelmann	
bark	10.37	......	7.46	14.53	5.10	41.95	3.26	0.80	19.98	0.20	0.62	......	....do	Engelmann	
Quince seeds, (Pyrus cydonia)	......	......	27.09	3.01	13.01	7.69	42.02	2.67	0.75	1.19	2.57	......	Misnia	Souchay	
Lemon seeds, (Citrus limonum)	......	......	33.89	3.56	8.67	12.87	34.81	3.30	0.35	0.24	2.31	......	....do	Souchay	

Orange tree (Citrus Aurantium) root	4.48	......	15.43	4.52	6.91	49.89	13.47	5.78	1.75	1.02	1.18	......	St. Michael	Rowney & How.	
stem	2.74	......	11.69	3.07	6.34	55.13	17.09	4.64	1.22	0.57	0.25	......	...do.		
leaves	13.73	......	16.51	1.68	5.72	56.38	3.27	4.43	4.83	0.52	6.66	......	...do.		
fruit	3.94	......	36.42	11.42	8.06	24.52	11.07	3.74	0.44	0.46	3.87	......	...do.		
seed	3.30	......	40.23	0.92	8.74	18.97	23.24	5.10	1.13	0.80	0.82	......	...do.		
Pine apple, whole fruit	......	......	49.42	......	8.80	12.15	4.08	Trace.	4.02	*2.93	17.01	0.88	England	Dr. Thos. Richardson.	*This column, in all Dr. Richardson's series, refers to the phosphate not the peroxyd of iron.
top	......	......	19.66	......	6.81	21.28	......	5.26	6.09	7.35	2.42	31.11			
Asparagus	0.47	93.27	6.01	34.21	3.03	4.39	18.51	4.13	13.47	3.31	12.94	......			
Onion, bulb	0.46	88.05	32.35	8.04	2.70	12.66	15.09	8.34	3.04	12.29	4.49	......			
Onion, stalk	0.84	93.53	13.98	14.43	Trace.	25.10	......	10.50	19.77	10.61	Trace.	......			
Fig, whole fruit	......	......	28.36	24.14	9.21	18.91	......	6.73	5.93	2.76	4.02	......			
Walnut, kernel	......	......	31.11	2.25	13.03	8.59	42.53	Trace.	......	2.49	Trace.	......			
shell	......	......	23.10	2.74	4.13	30.57	......	14.96	14.43	10.07	......	......			
Cucumber	0.63	97.78	47.42	......	4.26	6.31	14.97	4.60	7.12	2.06	9.06	4.19			
Broccoli, heart	1.01	87.96	47.16	......	3.93	4.70	24.83	10.35	0.69	2.12	Trace.	6.22			
leaves	1.70	87.42	22.10	7.55	3.43	26.44	16.62	16.10	1.83	6.21	......	......			
Cauliflower, heart	0.71	92.48	34.39	14.79	2.36	2.96	25.84	11.16	1.92	3.67	2.78	......			
Radish, root	6.43	65.10	21.16	......	3.53	8.78	40.07	7.71	8.17	2.19	7.07	1.29			
top	2.76	88.10	5.05	11.09	7.08	27.90	6.07	9.64	8.22	16.45	8.50	......			
Chestnut, whole fruit	0.99	54.61	39.36	19.18	7.84	7.84	7.33	3.88	2.32	1.95	4.82	......			Oxyd of manganese, 5.48.
Strawberries, whole fruit	0.41	90.22	21.07	27.01	Trace.	14.21	8.59	3.15	12.05	11.12	2.78	......			
Oranges, whole fruit	......	......	38.72	7.64	6.55	22.99	14.17	2.95	5.24	1.74	Trace.	......			
Rhubarb, stalk	0.69	95.92	59.59	0.46	......	10.04	12.83	1.89	2.77	2.77	8.84	......			
leaves	1.23	85.90	14.47	31.77	5.59	3.95	30.04	9.52	2.33	2.33	Trace.	......			
Spinach	2.03	90.53	9.69	34.96	5.29	13.11	7.89	9.30	3.16	8.67	7.93	......			
Kidney beans	0.68	87.12	36.83	18.40	6.33	7.75	14.60	3.96	4.09	5.24	2.80	......			
Pea pod	0.69	90.50	22.31	17.99	9.51	31.08	10.59	6.96	0.29	1.16	Trace.	......			
Greengages, whole fruit	0.40	83.77	59.21	0.54	5.46	10.04	12.26	3.83	2.36	6.04	Trace.	......			
Orleans plum, skin	0.89	68.05	58.86	3.52	9.29	8.25	9.85	1.96	0.81	7.45	Trace.	......			
pulp	0.31	90.25	54.89	8.72	4.69	4.86	15.44	3.23	3.15	4.80	0.62	......			
kernel	1.64	61.56	26.52	1.94	16.17	8.49	33.05	7.11	2.38	3.83	0.49	......			
shell	0.24	20.04	21.69	7.69	3.77	28.06	25.24	6.61	2.57	4.37	Trace.	......			
Cherry, whole fruit	0.43	82.48	51.85	1.12	5.46	7.47	14.21	5.09	9.04	3.74	2.02	......			
stalk	2.37	54.06	42.66	6.17	2.71	22.26	14.89	2.98	2.59	2.35	2.39	......			
Pear, whole fruit	0.41	83.55	54.69	8.52	5.22	7.98	14.28	5.69	1.49	1.96	Trace.	......			

Table showing the composition of the Ashes of Grasses, &c.—Continued.

Names of plants, or of their parts.	Ash in 100 parts.	Ash in plant, artificially dried.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Apples, whole fruit	0 27	84.01	35.68	26.09	8.75	4.08	12.34	6.09	4.32	2.65	......	......	England	Dr. Thos. Richardson.	
Artichoke	0.17	81.08	24.04	5.52	4.14	9.56	36.23	5.18	7.02	4.74	3.57	......			
Lettuce	0.87	93.96	46 01	5.29	2.17	6.05	8.52	3.89	20.23	Trace.	7.82	......			
Endive	1.37	93.48	37 87	12.12	1.77	12.03	......	5.21	24.62	6.36	Trace.	......			
Gooseberry	0.39	93.26	38.65	9.27	5.85	12.20	15.58	5.89	2.58	8.65	1.23	......			
Celery	1.07	91.50	22.07	......	5.82	13.11	11.58	5.58	3.85	2.66	......	33.41	....	....	Oxyd of manganese, 1.92.
Carrot	0.79	81.25	32.17	5.00	5.73	12.34	10.39	3.26	4.78	3.02	9 62	......	....	....	Do. trace.
Parsnip	1.49	75.86	36.12	3.11	9.94	11.43	18.66	6.50	4.10	3.71	5 54	......	....	....	Do. 0.89
Coffee beans	3.19	......	42.11	11.07	9.01	3.48	11.24	......	2.95	0.55	1.67	......	....	Levi	
Ergot, (Secale cornutum)	0.36	......	38.97	12.12	4.58	1.43	13.24	0.02	9 13	2.00	3.36	......	....	Engelmann	
Misletoe, (Viscum album)	......	......	40.71	......	11.06	22.37	19.74	1.62	1.87	1.46	1.17	......	Giessen	Will & Fresenius.	
Parmelia, (parasite on apple tree)	......	......	10.07	......	5.33	10.33	......	......	......	......	......	......	....	....	Phosphate of iron, 14.56.
Beech (Fagus sylvatica) wood	......	......	11.80	2.04	8.42	47.25	3.29	1.01	1.09	0 60	0.16	......	....	....	
seeds	......	......	22.82	9.50	11.64	24.50	20.81	2.20	1.88	2.67	0.87	......	Giessen	Souchay	
Oak (Quercus robur) wood	......	......	5.65	3.77	3.01	50.58	2.32	0.78	0.52	0.38	0.02	......	....do....	Denninger	
seeds	......	......	64.64	......	5.57	6.86	19.19	......	0.96	1.89	0.98	......	....do....	Kleinschmidt	
Elm (Ulmus campestris) wood	......	......	21.92	13.72	7.71	47.80	3.33	1.28	3.07	1.17	......	......	....do....	Wrightson	
bark	......	......	2.22	10.09	3.19	72.70	1.59	0.62	8.77	0.82	......	......	....do....	....do....	
Lime tree (Tilia Europœa) bark	......	......	16.14	4.53	8.03	60.81	4.02	0.75	2.27	1.24	2.21	......	....do....	L. Hoffmann	
wood	......	......	35.80	5.23	4.15	29.93	4.85	5.30	5.26	7.97	1.49	......	....do....	....do....	
Pine (Pinus sylvestris) seeds	......	......	22.37	1.26	15.09	1.86	......	10.44	10.44	3.01	......	......	....do....	Poleck	
wood	0.14	......	2.79	15.99	19.76	31.74	1.93	3.04	3.04	3.51	1.48	1.48	....do....	Bottinger	Red oxyd of mang., 18.17.
Larch (Pinus larix) wood	......	......	15.24	7.27	24.50	26.97	1.79	3.60	3.60	4.25	0.92	0.92	....do....	....do....	Do. 13.15.

(Pinus picea) seeds	......	......	21.71	6.76	16.79	1.54	......	11.71	11.71	1.31	0.57	0.57	....do....	Poleck	
(Pinus sylvestris) wood	......	......	7.17	6.26	9.19	31.50	2.07	5.72	5.72	2.23	0.81	0.81	....do....	Levi	
Sabine wood	0.85	......	0.83	3.29	2.97	77.32	2.42	0.39	0.39	1.36	......	......	....do....	Kochlin	
Madder root	8.25	......	20.39	7.37	2.60	24.0	3.13	1.45	3.63	2.13	10.04	......	Alsace	....do....	
Do	8.42	......	15.50	......	2.50	19.84	13.44	2.28	13.10	6.04	0.91	......	....do....	....do....	
Do	......	......	2.73	20.57	2.53	13.01	2.74	3.75	......	4.15	5.95	......	Zealand	May	
Moss, (Sphagnum palustre)	......	3.70	3.78	4.81	......	9.77	......	2.83	61.76	13.8	......	......	Germany	Wiegman	
Common land weeds.															
Hemlock (Conium maculatum)	......	......	12.80	21.69	9.64	8.39	24.96	3.45	2.62	2.40	16.61	......	Giessen	Wrightson	
Fox glove (Digitalis purpurea)	......	......	10.89	43.53	3.70	6.53	15.65	3.91	12.78	3.19	9.03	......	....do....	....do....	
Poppy (Papaver rhœas)	......	......	6.85	33.11	......	5.06	23.37	2.26	1.41	1.21	......	3.40	....do....	Ruhling	
Corn-cockle (Agrostemma githago)	......	......	13.20	22.86	......	6.14	29.27	2.39	2.39	1.21	......	7.55	....do....	....do....	
Common blue bottle (Centaurea cyanus)	......	......	7.32	36.54	......	4.56	15.49	2.69	3.29	1.61	......	11.88	....do....	....do....	
Common chamomile (Anthemis nobilis)	......	......	9.66	30.58	......	3.67	16.01	4.60	6.80	3.28	......	7.15	....do....	....do....	
Wild chamomile (Matricaria chamomilla)	......	......	9.69	32.39	......	4.79	16.42	4.34	1.53	1.65	......	14.26	....do....	....do....	
Do	......	......	8.51	25.49	......	4.94	19.10	4.99	1.65	1.65	......	18.49	....do....	....do....	
Sweet flag (Acorus calamus)	......	......	6.90	32.93	......	7.70	11.48	5.06	2.39	1.91	2.84	14.66	....do....	....do....	
Datura stramonium (seeds)	......	......	20.22	14.24	17.56	4.11	34.72	......	5.21	3.94	......	......	....do....	Wrightson	Iodide of sodium, 0.34.
Sea weeds.															
Fucus digitatus	......	20.40	20.66	7.65	6.86	10.94	2.36	12.33	1.44	0.57	26.18	......	......	Godechens	Iodide of sodium, 0.32.
Fucus vesiculosus	......	16.39	13.01	9.54	6.12	8.36	1.16	24.06	1.15	0.28	21.45	......	......	Godechens	Do. 0.49.
Fucus nodosus	......	16.19	9.13	14.33	9.91	11.60	1.38	24.20	1.69	0.26	18.28	......	......	Godechens	Do. 1.18.
Fucus serratus	......	15.63	3.98	18.67	10.29	14.41	3.89	18.59	0.38	0.30	16.56	......	......	Godechens	
Laminaria latifolia	......	13.62	......	......	0.78	1.61	0.81	1.45	0.08	......	2.24	4.24	Hoffmannsgen	Forchammer	
Laminaria digitata	......	......	4.24	......	......	2.50	0.79	5.05	0.11	......	7.90	......	Heligoland	Forchammer	
Ecklonia buccinalis	......	14.27	2.67	0.94	0.73	3.11	0.43	1.84	0.48	......	2.15	......	Cape of G. Hope	Forchammer	
Padina pavonia	......	34.75	......	......	......	25.29	3.93	4.46	......	......	......	......	West Indies	Forchammer	
Durvillaea utilis	......	......	2.46	1.30	0.17	2.87	0.55	4.04	......	......	6.8	......	Chili	Forchammer	
Fucus vesiculosus	......	......	0.98	0.80	1.19	2.82	0.58	2.86	1.20	......	0.38	......	Taarbeck	Forchammer	The analyses of Forchammer refer to the ashes contained in 100 parts of the *plants*, while the previous analyses of of sea weed are made on 100 parts of the *ashes* themselves.
Do	......	16.22	2.64	2.64	1.10	1.16	0.82	2.06	......	......	3.81	......	Denmark	Forchammer	
Halidrys siliquosa	......	15.65	......	......	......	......	......	3.44	......	......	4.70	......	Greenland	Forchammer	
Sargassum vulgare	......	22.58	5.00	1.02	1.09	4.39	0.45	3.61	......	......	7.09	......	Hoffmannsgen	Forchammer	
Sargassum cocciferum	......	11.62	0.09	0.81	0.68	5.69	0.38	2.22	0.19	......	......	......	Bay of Campeachy	Forchammer	
Furcellaria fastigiata	......	18.92	3.83	4.44	1.98	1.40	0.39	5.65	......	......	......	......	Atlantic	Forchammer	

Table showing the composition of the Ashes of Grasses, &c.—Continued.

Names of plants, or of their parts.	Ash in 100 parts.	Ash in plant, artificially dried.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric acid.	Sulphuric acid.	Silica.	Peroxyd of iron.	Chloride of sodium.	Chloride of potassium.	Locality of plant.	Analyst.	Remarks.
Chondrus crispus	....	20.61	3.57	3.86	2.34	1.48	0.08	8.50	......	......	......	......	Kattegat	Forchammer ...	
Chondrus plicatus	......	11.23	0.76	0.91	0.70	1.38	0.44	1.64	......	......	1.98	......	....do		
Iridaca edulis	......	9.86	1.19	0.78	......	1.05	0.65	1.28	......	......	0.08	......	Hoffmannsgen ...		
Delesseria sanguinea	......	13.17	1.73	2.69	0.75	0.51	0.27	5.13	......	......	......	......	Kattegat		
Polysiphonia elongata	......	......	3.43	0.52	2.32	0.69	0.26	4.63	0.48	......	2.22	......	Hoffmannsgen ...		

ASHES.

When any organic substance—with few exceptions, if any—is burned in contact with the air, there remains an incombustible residuum called ashes, consisting of that portion of the plant which is exclusively mineral. The ashes vary according to the nature of the plant, the portion consumed, and the geological formation and other characteristics of the locality in which it grew. As has been stated, the substances composing the ash are as essential as the organic or combustible portion of the plant. Most of the plants which grow in sea water, or near the ocean, contain soda, and also potash. Even wheat, when grown near the borders of salt water, though in soil containing little or no soda, is found to yield soda. These substances have very similar properties, and are to a certain extent interchangeable in certain plants; but this is the exception, and not the rule. Sea plants, though always containing soda, are never without potash; in most cases, indeed, it predominates. As like causes produce like effects, plants that are similar and grown under similar conditions, produce ashes that are similar.

Different parts of the same plants, as the leaves, the branches, the trunk and the roots, yield ashes of different composition. Professor Johnston has shown that "the difference existing in the mineral contents of the straw of wheat may be as great as from three to eighteen per cent.; and in oats from three to ten per cent.; and, under certain circumstances, is greater at the bottom of the stem than at the top." The amount of mineral food is greater in the leaves than in any other portion; and it is precisely in that part of the plant where assimilation is most active. The tuber of the potato contains in its ashes as much as eighty-six parts in the hundred of the salts of potash and soda; while the ash of the top contains only four parts of those substances. The tuber gives only fourteen parts of lime, and no silica; while the top contains as high as thirty-six parts of silica. Mr. Th. J. Herapath has given the following results of analyses of the potato, all the varieties having been grown upon the same soil and under precisely similar circumstances:

Ash analysis of five varieties of potato.

	White Apple.	Penn's Beauty.	Axtridge Kidney.	Magpie.	Forty-fold.
Carbonic acid	21.059	16.666	21.400	18.162	13.333
Sulphuric acid	2.774	4.945	3.244	5.997	6.780
Phosphoric acid	5.716	8.920	3.774	6.669	11.428
Potash	53.467	54.166	55.610	55.734	53.029
Soda	Trace	Trace	Trace	Trace	Trace
Chloride of sodium					2.095
Carbonate of lime	0.844	2.049	3.018	1.954	2.286
Carbonate of magnesia	3.530	0.273	1.257	2.565	0.570
Sulphate of lime	Trace	Trace	0.125	Trace	Trace
Phosphate of lime	3.363	0.683	3.835	5.374	2.856
Phosphate of magnesia	9.247	12.298	7.550	3.545	7.623
Phosphate of iron	Trace	Trace	0.062	Trace	Trace
Phosphate of alumina	do	do	Trace	do	do
Phosphate of manganese	do	do	do	do	do
Silicic acid			0.125	do	do
	100.00	100.00	100.00	100.00	100.00

Analysis has shown that the ashes of grain give a different result from those of the straw; and this is particularly illustrated in the wheat plant. The grain is rich in phosphoric acid and in magnesia, while the straw yields but a small proportion of either substance. The straw contains much silica; the grain but little. By exporting the grain from the farm, therefore, the soil is impoverished of certain minerals which are not returned to the land in the straw.

The mineral portions of all vegetable and organic matters exist in the ashes and in the plant in different conditions. In the latter case they are more or less combined with organic acids, such as tartaric, malic, pectic and oxalic. These acids are combustible, and when the plant is reduced to ashes they are destroyed, leaving the minerals themselves more or

less altered and differently combined. In the decaying plant they are in assimilable condition, passing from one state to another, not having been segregated by the effect of heat, which, according to its intensity, has a disadvantageous effect upon their action as fertilizers. Thus silex, which in the plant may have been in atomic division and soluble by the effect of heat, becomes gritty and insoluble. The alkalies may by the same agent enter into insoluble conditions with that substance, and thus be rendered inert for an indefinite period.

As the ash of a plant represents the mineral food which has once been assimilated, so far as their nature in this capacity has not been destroyed by heat, so far are they useful for fertilizing. All plants yield ash residuums; but they differ in their richness in certain constituents according to the nature of the plant from which they may have been extracted. None can be useless; and they vary in value only according to certain constituents which are considered more rare and more valuable than others. Besides, as has been stated, their value may be deteriorated by the degree of heat to which the organic matter has been subjected. A large amount of carbonaceous matter, from the imperfect combustion of the organic portion, is not disadvantageous; as we know that charcoal is a condenser of gas, and sometimes absorbs as high as ninety times its volume of certain gases. Ashes are also deteriorated in value by lixiviation; those exposed to rains, or which have been leached for soap-making, being less valuable by the amount of alkali removed. The ash of a plant that yields much phosphoric acid, potash, or soda, is more valuable than those obtained from plants which are poor in those substances. Ashes can only be used as auxiliaries to other manures, and will be comparatively without effect if the soil is without organic matter. For, notwithstanding that the atmosphere contains the organic elements, it must be borne in mind that the plant derives a portion of its organic nourishment from the soil. Ashes have a good effect upon stiff soils in causing a division of the particles, their non-adhesive nature counteracting the tenacity of such soils; while, independent of this mechanical action, their chemical composition has the same value in this as in any other application.

Peat ashes differ very materially from those of wood, the soluble portions, from their continued contact with water, having been removed. Peat bogs formed in calcareous formations are rich in the salts of lime, which gives a value to them not belonging to those which occur in other rock formations. The ashes of peats taken from different localities differ so widely in their composition that their value as fertilizers should be determined by a special examination for every locality whence they are taken. They have been found especially useful for top-dressings of swards, clover and varieties of peas, which is explained by the presence of the sulphate and carbonate of lime. When the phosphate of lime is present, they have a vastly greater value and a much wider range of usefulness, and will prove beneficial to all the crops in which that important element is essential, such as turnips. Mr. Charles T. Jackson has given several analyses of the ashes of peat, from Rhode Island and Massachusetts, as follows:

Analyses of the Ashes of Peat from Rhode Island and Massachusetts.

Number.	Location.	Remarks.	Water.	Ashes.	Vegetable matter.	Silica.	Iron and alumina.	Lime.	Magnesia.	Potash and loss.
1	Cranston, Rivulet farm.			13	87	8	2.2	2.8		
2	Block island, west side		25.25	6.35	63.4	4.5	0.75	1.1		
3	Bristol, ——— Bullock's	Light and porous		13.9	86.1					
4	Cumberland, J. Whipple			76	24	69.3	3.2	0.5	0.3	
5	Cumberland Hill, Sneech pond	Light, flaky, and fibrous; color brown		2.15	97.85	0.45	0.25	1.30		1.5
6	North Kingston, Governor Arnold	Compact; red brown		25.6	74.4	21.2	2.4	1.5		0.5
7	North Kingston, W. Carpenter	Heavy		65	35	57.6	0.5	.55		
8	South Kingston, J. D. Austin	Ashes, mostly of silica		62.5	37.5					
9	South Kingston, Point Judith, near windmill	Gravelly, rather heavy and fine		68.4	51.6	41.35	4.20	1.2	0.3	
10	Do.....do			10.5	89.5	7.0	1.5	0.6		*1.2
11	Cranston, ——— Potter			7.9	92.1	6.3	0.9	0.7		
12	Pawtuxet, C. and W. Rhodes			11.4	88.6	9.5	1.9			
13	Wickford, Judge Pitman		15.9	11.5	72.6	8.9	1.5	1.1	0.2	
14	Woonsocket		10	1.8	88.2	0.5	0.3	0.6		0.4
15	Warwick, Mr. Westcott		13.5	49	37.5	40.7	5.1	3.2		
16	Warwick, J. F. Arnold			4	96					
17	Wickford, Mr. Sanford			12	88					
18	S. Kingstown, Boston neck, Room farm			17.5	82.5	12	2.1	2.5	0.5	0.4
19	Pawtuxet, Wm. Rhodes			32.5	67.5					
20	Warwick, Pottawoomett, R. W. Greene, esq			10.5	89.5					

* Phos. manganese.

It may be well, for the sake of comparison, to subjoin here a number of analyses of peat ashes from foreign sources, as follows:

Two samples of peat ashes analyzed by Thaer and Einhof, showing an extraordinary quantity of phosphoric acid:

Lime	15.25	20.0
Alumina	20.50	47.0
Oxyd of iron	5.50	7.5
Silica	41.00	13.5
Phosphate of lime	15.00	9.5
Common salt and gypsum	3.10	2.6
	100.35	100.11

Analyses of peat from Brunswick, by Wiegman, showing the presence in some varieties of considerable quantities of phosphate of lime:

Sulphate of lime	48.75
Silica	22.00
Sand	142.00
Alumina	96.00
Peroxyd of iron	66.00
Phosphate of lime	16.00

Analyses of two samples of peat ashes from different parts of Berkshire, made by Playfair.

Carbonate of lime	62.50	58.0
Oxyd of iron	2.63	4.25
Alumina	1.03	
Silica (soluble in acids)	1.10	1.12
Sulphate of potash	2.15	0.37
Sulphate of soda	1.16	trace
Sulphate of lime	1.11	2.88
Phosphate of magnesia	0.37	0.46
Chlorine	trace	trace
Organic matter	4.81	4.25
Sand and clay	14.01	11.19
Water	7.31	17.21
Loss	0.12	0.27
	100.00	100.00

Table showing the composition of certain foreign peat ashes.

	Ichaux.	Voitsumra.	Vassy.	Framont.	Hagenau.
Lime	----------	2.0	--------	30.0	60.0
Carbonate of lime	63.0	----------	51.5	----------	----------
Clay	7.5	----------	11.0	----------	----------
Silica	15.0	36.5	--------	40.0	6.5 with sand.
Alumina	7.0	17.3	--------	30.0	16.2
Oxyd of iron	9.0	33.0	11.5		3.7
Potash and soda	0.5	----------	--------	----------	2.3
Magnesia	----------	3.5	--------	----------	0.6
Sulphate of lime	----------	4.5	26.0	----------	----------
Sulphuric acid	----------	----------	--------	----------	5.4
Chlorine	----------	0.3	--------	----------	0.3

Peat ashes, like all others, act mechanically, and improve sticky or tenacious clays by interposition. Peat, when dried and burned, or rather charred, would in some instances be a most valuable addition to lands, acting mechanically and chemically upon them, the charred vegetable matter changing the temperature of light colored lands by merely changing the color, and destroying the adhesiveness of clays by the arenaceous property of the charred peat. The charcoal would be a collector of gases, such as ammonia, and thus prove a permanent meliorator of the soils, but more especially of stiff clays.

Burning peat for its ashes has been prosecuted as a regular business in Holland, whence they are exported to Great Britain and to Belgium. The consideration in which they are held in the last mentioned country is due to the quantity of phosphate and sulphate of lime which they contain. According to Sprengel, 3,000 pounds of the best quality of peat ashes from Holland contain 300 pounds of sulphate of lime (gypsum) and 120 pounds of phosphate of lime. This explains their action upon clover and other forage crops. Mr. Mitchell,* in speaking of their use, says: "As a top dressing, these ashes are superior to common manure, it having been found in Flanders that the crops of clover, where the ashes were used, were much earlier, heavier and superior in every respect to those which have undergone a dressing of horse and cow-dung. As a top-dressing to the second crop of clover, they will be found highly advantageous. One of the best proofs of their usefulness is the fact, that while we have frequently in this country very backward and light crops of clover-grass, in Flanders, where this top-dressing is used, such a defection seldom or never occurs."

Sir John Sinclair quotes the declaration of eighty-three practical farmers that "they know by experience when clover is not manured with peat ashes to the amount of nineteen bushels to the acre, the following crop is very bad, notwithstanding any culture that can be given to the soil; whereas they always have an excellent crop of wheat after clover, and doubtless in proportion to the quantity of the above manure used."

In the counties of Newberg, Berks and Hampshire, peat ashes are in high repute as a dressing for clovers, sainfoin, rye, grasses and rape, which is natural, as the ashes used contain the phosphate and sulphate of lime, and also some potash. Wherever manures are used upon the turnip crop, whether mineral or organic, if they contain phosphate of lime, they will be found of great advantage. It is to be regretted that the scientific annals of our country are not rich in the analyses of our peat ashes, or those of our coals, since it is believed when the methods now known for detecting and dosing phosphoric acid, a greater value will be attached to our peats as fertilizers, particularly on account of the phosphoric acid they all doubtless contain in greater or less proportion.

The effect which the writer has observed to follow the application of peat on his own land induces the belief that their action is more than is represented by the mechanical agency, or that which is due to their absorbing faculty. Peat ashes are said to be of great and particular service to crops of sainfoin; and such efficiency to that particular crop might have been expected *a priori,* since calcareous fertilizers are essential to its growth, the plant scarcely thriving at all on other than calcareous soils. Professor Johnston has found as high as six and a half per cent. of phosphate of lime in a peat taken from the Island of Lewis.

As a top-dressing for oats Mr. Gardner, of Paisley, obtained the following results from peat ashes:

Produce of grain per acre.

	qr.	*bu.*	*p.*
No manure	6	3	0
African guano, 2 cwt	6	7	2
Peruvian guano, 2 cwt	7	6	3
Peat ashes, 80 bushels	7	1	2

Mr. Gardner remarks: "The peat ashes were made from burning flow moss in the open air, with the fire kept closely covered in. They were about ten days later of being put on the oats than the other dressings, and it continued dry weather for some time after they were put on, and prevented them from having the effect they would have had, had they been put on earlier in the season. However, from their known composition they are a most valuable dressing, and will, no doubt, add greatly to the fertility of most soils, and are particularly worthy of notice from the ease with which they can be produced, in almost any quantity, in every county in Scotland." According to the analysis of Professor Johnston, the peat ashes employed in the above trial contained 3 per cent. of organic matter and 21 per cent. of gypsum.

The application of peat ashes cannot be economically made without a previous knowledge

* Transactions of the Highland Society.

of their constituents; and that knowledge will enable the farmer to judge of the manner they should be applied and their quantity. Like all mineral manures, their action is continuous for a long time; and, according to Sprengel, "a good dressing will last for five or six years." Their duration, however, is dependent upon their composition, as well as the activity they may impart to different vegetations.

Peats yield ashes of qualities differing according to the positions from which they are taken. Those from the top of the bed, after removing the surface, are considered less valuable than those from the bottom layer, the top being more fibrous and less compact than the bottom, which, when dry, often presents an entirely different appearance from the turfs ordinarily used for fuel.

When it is designed to consume the peat entirely, leaving no vegetable matter, it should be well dried, and may then be burned in contact with the air, either in conical heaps, in furnaces, or in kilns made for the purpose. But where the object is two-fold, or where the charring of the peat is the desired result, a process similar to that employed for charring wood may be employed. But the charring of peat will be attended with much greater difficulty, as the organic fibers are much more divided and difficult to extinguish, partaking more or less of the properties of pyrophorus.

Thus, according to the inclinations of the operator, the peat may be burned, leaving a pure ash free from coal, or a mixture of ash in any proportion contained or that is practicable or compatible with the method employed in the operation. Charred peat acts mechanically or chemically according to the composition of the ash, as a disinfectant, or as an absorbent.

Much of what has been said of peat ashes is applicable to *coal* ashes. There are many varieties of coal, and the composition of the ashes is as varied. Some coals are metalliferous, containing much sulphuret of iron; others are impregnated with sulphuret of copper; others are more or less mixed with earthy substances, passing by insensible gradations into slates. By combustion in contact with the air the sulphur is driven off, and the oxyd of iron remains. Unfortunately, few examinations have been made of the ashes of American coals.

The following analyses are of high authority, and give a fair view of the composition of coal in the various cases:

Ashes of anthracite coal, analyzed by Professor Norton, of Yale College.

	White ash.	Red ash.
Matter insoluble in acids	88.68	85.65
Soluble silica	0.09	1.24
Alumina	3.36	4.24
Iron	4.03	5.83
Lime	2.11	0.16
Magnesia	0.19	2.01
Soda	0.22	0.16
Potash	0.16	0.11
Phosphoric acid	0.20	0.27
Sulphuric acid	0.86	0.43
Chlorine	0.09	0.01
	99.99	100.11

Bituminous coal of St. Etienne, in France, analyzed by Berthier.

Alumina, insoluble in acids	62.00
Alumina, soluble	5.00
Lime	6.00
Magnesia	8.00
Oxyd of manganese	3.00
Oxyd and sulphuret of iron	16.00
	100.00

Table showing the composition of the ashes of coal, analyzed by A. Phillips.

Name of coal.	Silica.	Alumina and oxyd of iron.	Lime.	Magnesia.	Sulphuric acid.	Phosphoric acid.
Pontypool	40.00	44.78	12.00	Trace.	2.22	0.75
Bedwas	26.87	56.95	5.10	1.19	7.23	0.74
Porthmawr	34.21	52.00	6.20	0.66	4.12	0.63
Ebbu Vale	53.00	35.01	3.94	2.20	4.89	0.88
Fordel Splint	37.60	52.00	3.73	1.10	4.14	0.88
Wallsend Elgin	61.66	24.42	2.62	1.73	8.38	1.18
Coleshill	59.27	29.09	6.02	1.35	3.84	0.40

The mixture of coal ashes with night soil has long been practiced; but, independent of any admixture, the coal ashes of Great Britain, with few exceptions, contain as constituents the carbonate and sulphate of lime; and they have invariably been found to increase leguminous crops, clover, lucerne, peas, beans, and sainfoin; and, as in the ashes of peat, though in a less degree, the unconsumed coal acts as an absorbent.

Coal ashes may be used with the greatest benefit about slaughter-houses, as an absorbent of the blood and liquids, which cannot be applied to land without immediate benefit. The ashes thus enriched not only have a mechanical action upon stiff clays, by diminishing the characteristic cohesion of aluminous soils, but, by the nitrogenous substances they have absorbed, render crops luxuriant that cannot be grown successfully without such addition to the soil. By destroying the cohesion, as has been remarked, water and air are admitted, the soil is pulverized, the temperature is elevated, and the roots of plants are permitted to penetrate and bathed in a constantly renewed fertilizing atmosphere; and the tearing effect of baking will thus be diminished, if not destroyed. If the coal ashes be sifted and mixed with night soil, or with liquid animal offal, to the extent that this is rich in fertilizing constituents will the mixture be advantageous when drilled in with seed or otherwise applied. The quantity used must depend upon the proportion of animal matters. This application of ashes is worthy the attention of farmers; and the compost that may be thus economically prepared on every farm will prove of far greater value than many fertilizers for which very high prices are unhesitatingly paid.

SULPHUR.

This simple substance cannot be ignored as one of the constituents of organic matter. It is known to commerce under the names of brimstone and stick or roll sulphur, and is sold by druggists and used in medicine in a form known as "flour of sulphur," differing in no respect from other varieties of pure sulphur, except in being in a finely divided state, approaching almost to atomic division. Sulphur is found variously combined with metals, in the form of sulphurets. Thus we have the sulphuret of lead, (or galena,) sulphuret of copper, sulphuret of iron, &c. Much is prepared for commercial uses from the decomposition of the sulphurets of iron and copper, as in the Hartz mountains and other metallurgical districts. In this locality there are immense heaps of those minerals thrown together, and either heated artificially, or the spontaneous generation of heat by chemical decomposition is sufficient to sublime the sulphur, which is collected. But by far the largest amount consumed in the arts is derived from volcanic regions. Sicily supplies much of that used in Europe.

Sulphur also exists in combination with oxygen, as sulphuric acid, and is met with in nature combined with barytes as sulphate of barytes, (heavy spar,) sulphate of lime, or gypsum, sulphate of strontian, &c. It is partly owing to the presence of sulphureted hydrogen evolved from putrifying organic matter that such emanations are so nauseating. When a silver spoon is allowed to remain in contact with the matter of eggs, the black appearance assumed by the metal is owing to the sulphur which combines with the metal, forming a sulphuret.

It is frequently observed upon the surface of stagnant pools, and is also deposited from certain mineral waters. The dark colored mud found surrounding such waters has been applied to curing diseases of the skin. The curative principle resides in the sulphur which has accumulated from the water. Many springs in our country are known by the name of

sulphur waters, and generally emit the disagreeable odor of rotten eggs, characteristic of sulphureted hydrogen. Sulphur is an ingredient of ointments used for cutaneous diseases. When taken internally, it acts as a laxative and diaphoretic.

Sulphur is a combustible of a non-metallic nature. Its specific gravity is 1.99. It melts at a temperature of 216° of Fahrenheit. On cooling it crystallizes, which may be observed by examining the interior structure of a roll of sulphur. It takes fire in the air at a temperature of 300° Fahrenheit, burns with a pale blue flame, giving off suffocating vapors of an acid character, containing less oxygen than sulphuric acid, and known as sulphurous acid. It is insoluble in water, but under particular circumstances gives a milk-white appearance to water in which it is found in this state of hydrate, sometimes called "milk of sulphur." It is soluble in boiling turpentine. As has been stated, it forms acids in combination with oxygen. Sulphuric acid is one of the most powerful acids known. It combines with hydrogen, as has been seen; also with the alkalies and earths. It is hardly necessary to state that it is one of the principal constituents of gunpowder, and enters largely into the composition of artificial fireworks. Of late years it has been extensively employed in combination with caoutchouc, which in this state is manufactured into many forms and for multifarious uses, and is known as vulcanized rubber, ebonite, &c.

According to Henry Clifton Sorley, 100 pounds of the following plants, dried perfectly at 212° Fahrenheit, contain—

	Sulphur.
Four species of grass (*Poa palustris, P. trivialis, Festuca pratensis, Cynosurus cristatus*)	.165
Perennial rye grass	.310
Italian rye grass	.329
Red clover, (*Trifolium pratense*)	.107
White clover, (*Trifolium repens*)	.151
Yellow clover, (*Medicago lupulina*)	.136
Lucerne, (*Medicago sativa*)	.274
Lucerne	.452
Lucerne	.293
Vetches, (*Vicia sativa*)	.178
Kidney potatoes	.094
Kidney potato leaves	.389
American potatoes	.082
American potato leaves	.206
Carrots, (*Daucus carota*)	.092
Carrot leaves	.745
Beet root (*Beta altissima*)	.058
Beet root leaves	.502
Turnips, (*Brassica rapa*)	.351
Turnips	.421
Turnip leaves	.758
Swedes, (*Brassica oleracea*)	.439
Swedes, tops	.458
Rape, (*Brassica oleifera*)	.448
Cabbage	.431
Wheat, whole plant, shortly before flowering	.151
Wheat ears, fully formed, but still milky	.075
Wheat straw	.240
Wheat grain, with chaff	.090
Wheat chaff	.213
Red wheat	.070
Red wheat straw	.293
White wheat, grown on the same field as the red	.054
White wheat straw	.207
Very good barley	.066
Very good barley straw	.390
Inferior barley	.040
Inferior barley straw	.191
Barley in flower	.313
Oats, whole plant	.226
Oats in flower	.189
Black oats	.125
Black oats' straw	.329
Black Tartary oats	.080
Black Tartary oats' straw	.271

	Sulphur.
Rye, young ears	.073
Rye straw	.099
Rye grain	.051
Beans, whole plant	.045
Beans	.071
Bean straw	.148
Peas	.158
Pea straw	.214
Hops	.127

According to Professor Way:

	Sulphur.
Rye grass	.006
Red clover	.047
White clover	.037
Sainfoin	.006
Beans	.029
Peas	.027

And according to Professor Johnston:

	Sulphur.
Common parsnip	.999
Cabbage, (great York)	1.058
Cabbage, (sugar-loaf)	1.013

It will be seen that the proportion of sulphur which is found in plants is subject to considerable variations, and that it is greatest in the straw and leaves.

Recent investigations have shown the presence of phosphorus where it was not formerly even suspected. The accepted analyses of many substances are consequently doubtful, if not certainly erroneous, on account of the ignoring of the presence of this substance, not because of the want of ability in the eminent docimassists to whom science is indebted for valuable labors, but of the imperfectness of science at the time of such investigations. Phosphorus is now known to form a notable and important constituent of the granites and other crystalline rocks, of countless organic and inorganic substances, and of the air itself, from which it is derived as an element of fertility to soils. In reported remarks on "Organisms," published in the Journal of the United States Agricultural Society for 1857, the following passage occurs:

"That all the requirements of vegetation existed in the air and soil; that the want of phosphoric acid and ammonia was more imaginary than real; that the former was found to be present in all rocks, in the oceans, all water, the air, and the soil, and in ample proportions for the supplies of animated nature; that it had not been detected by chemical experiment in the air was not conclusive proof of its non-existence; that there were higher evidences than the results obtained by chemical re-agents and balances; that the omnipresence of phosphoric acid and the known presence of ammonia in the air, water, and soil, were the natural consequences of the order of creation; that chemistry had settled the question that phosphorus was a constituent of organic substances; that it existed uncombined in the brain of animals, and that Thenard had given an explanation of the cause of those lights seen over graveyards, marshes, and elsewhere, called 'jack o'lantern,' 'will of the wisp,' &c., in attributing them to the decomposition of animal matter, giving rise to phosphureted hydrogen, which, it is well known, takes fire when it comes in contact with the air, and finally is resolved into phosphoric acid. It would not therefore be extraordinary, considering the solubility of phosphoric acid, that it should exist dissolved in the atmospheric humidity."

With regard to the condition in which the acid exists, the report continues: "It does not follow because a substance is not volatile that it should not exist in the atmosphere; for, independent of those mineral constituents which form part of vegetable and animal organisms, finely comminuted sand and other substances are held in suspension and carried by the winds; small bodies, such as fish, frogs, &c., fall down as rain, and certain varieties of meteorites have been found to be composed of organisms." And again: "It is not, then, surprising if phosphoric acid and ammonia should be found in the air, and earth, and water. It would be more surprising if they were not. Being the result of the decomposition of all animal and vegetable matter, they will be found in all climes from the poles to the equator."

In view of these statements, the following remarks upon the "dosage" of phosphoric acid, derived from Mr. Chancel, and kindly presented to the writer by M. Barral, will doubtless be recognized as acceptable and important:

DOSING PHOSPHORIC ACID.

This process is based upon the entire insolubility of phosphate of bismuth in liquids containing free nitric acid, even in a notable proportion. Chemists have scarcely done more than indicate the existence of this body, when it would have been well to point out its composition and the conditions in which it is formed. It constitutes, indeed, one of the best defined combinations in chemistry, and adapts itself to all kinds of analytical operations, such as filtering, washing, calcination, &c. On this subject I give the following as the result of my observations:

If we pour into a liquid containing a phosphate dissolved by means of nitric acid a solution of nitrate acid of bismuth sufficiently diluted to be no longer troubled by water, a fine white precipitate is immediately formed. It collects rapidly, and is very dense, particularly when hot, leaving a perfectly limpid liquid. A great many experiments by synthesis and analysis demonstrate that the composition of the precipitate thus obtained is invariable, and may be represented by the formula $Bi\ O^5,\ PO^5$.

This salt is therefore a neutral phosphorus, since the triatomic particule of oxyd of bismuth replaces the three particles of water of tribasic phosphoric acid.

The neutral phosphate of bismuth is quite insoluble in water, and in nitric acid diluted, either cold or at the temperature of ebullition; it dissolves sensibly in liquids containing much ammoniacal salts. The filtering of the liquid in which it is held in suspension does not require any special precaution, a few washings with water sufficing to remove every trace of foreign soluble substances. Its desiccation is very rapid; and, as it is not fusible at a red heat, it may, without fear, be calcined in a crucible of platinum over a lamp with a double current of air. The recent labors of M. Dumas give the number 210 as the equivalent of bismuth, and by introducing this value into the preceding formula we find that neutral phosphate of bismuth contains 23.28 per centum of anhydrous phosphoric acid.

[NOTE.—Phosphoric or tribasic acid is here represented by the usual symbol PO^5; phosphoric or bibasic acid by $p\ PO^5$, and metaphosphoric or monobasic acid by $m\ PO^5$. The German chemists use the formulas $c\ PO^5$, $b\ PO^5$, and $a\ PO^5$, to designate the three acids.]

Pyrophosphoric acid, $p\ PO^5$, is quite as completely precipitated by nitrate acid of bismuth. If we pour this re-agent into the cold solution of a pyrophosphate, a white precipitate is formed, which is of much larger volume than that given by tribasic phosphoric acid. This precipitate is considerably reduced by desiccation, and furnishes, by analysis, numbers which perfectly agree with the formula $2\ Bi\ O^3,\ 3\ p\ PO^5$, in which the relation of the oxygen of the base to that of the acid is as 2 : 5. This composition is then neutral pyrophosphate of bismuth, and contains 31.28 per cent. of pyrophosphoric acid. Experiment also proves that it is the pyrophosphoric acid, and not tribasic phosphoric acid which exists in the product obtained in the conditions indicated. In fact, if, after having washed the precipitate with cold water, it is treated in suspension in water with sulphureted hydrogen, sulphuret of bismuth is formed, which may be separated by filtering; the filtered water, previously freed of the excess of sulphureted hydrogen, precipitates a beautifully white salt of silver. But, in an analytical point of view, unquestionably the most interesting property that this pyrophosphate presents is its complete and instantaneous transformation into tribasic phosphate, $Bi\ O^3,\ PO^5$, when heated together (*en presence*) with an excess of nitrate acid of bismuth. Thus it is enough to bring the liquid to a state of ebullition, in order at once to change its appearance and render it more dense. Washed and dried, its composition then is $Bi\ O^3,\ PO^5$; and, decomposed by sulphureted hydrogen, it furnishes an acid which gives a yellow precipitate with the nitrate of silver.

The metaphosphates have the same characteristics, except that the precipitate of bismuth requires a longer ebullition to be completely transformed into ordinary phosphate. Decomposed by sulphureted hydrogen, it then gives an acid which does not coagulate albumen, and which precipitates a yellow nitrate of silver, after having been exactly neutralized by ammonia. All these points authorize us to conclude that, in the dosings in the form of phosphate of bismuth it is not necessary to ascertain under what modification phosphoric acid is found in the substance to be analyzed.

The precipitation of phosphoric acid by nitrate acid of bismuth is not only complete, but also of extreme sensibility. Thus has it been possible to discover and characterize clearly one milligramme of phosphoric acid in 120 milligrammes of aluminum in a diluted solution containing more than a gramme of free nitric acid. As the precipitation is very rapid under heat, and as the liquor clarifies almost instantaneously, it will be easy to dose phosphoric acid by a liquor treated with nitric acid of bismuth. Such a process might be very useful for the analysis of physiological or industrial products.

Preparation of the Re-agent.—Salts of bismuth, having a strong tendency to divide into acid salts and basic insoluble salts, it becomes indispensable that the re-agent to be used should be of a solution so diluted and acid as not to be further troubled by ebullition or by water, no matter in what proportion added. This condition will be obtained when the solution shall contain ten or twelve equivalents of nitric acid, supposed to be anhydrous, for the equivalent of oxyd of bismuth, $Bi\ O^3$. Repeated experiments have demonstrated that, in order to obtain a suitable re-agent, as well for qualitative researches as for quantitative determinations, it is necessary to dissolve, by hot water, one part of sub-nitrate of bismuth, pure and crystalline, ($Bi\ O^3$, $NO^3 + A_9$,) in four parts of nitric acid of 1.36 density, adding to the solution thirty parts of distilled water, heated to boiling and filtered, if necessary. Every cubic centimeter of the re-agent, thus prepared, will precipitate from seven to eight milligrammes of phosphoric acid.

Analysis.—The separation and dosing of phosphoric acid, with the different bases, is very simple by means of this re-agent. Weigh the substance, and, if it is not soluble in water, treat it with a sufficient quantity of nitric acid, being careful to avoid excess. When all is dissolved, the solution must be diluted with distilled water, pouring in nitrate of bismuth until this re-agent no longer occasions precipitation, heating to ebullition, filtering and washing with boiling water. The washing is extremely rapid, and we satisfy ourselves of its completeness either by evaporating a drop of liquid which filters from it upon a plate of platinum, or by treating with sulphureted hydrogen, which must not produce the slightest coloring. We must then dry the precipitate with care, then remove it as completely as possible from the filter, reduce this to ashes separately in a tared (or previously weighed) crucible of platinum, add then the principal precipitate, calcine to a red heat, and weigh when completely cold. The weight of the precipitate, multiplied by 0.2328, gives the quantity of phosphoric acid contained in the substance analyzed. The bases are dosed without difficulty in the filtered liquor, after having expelled the excess of bismuth by sulphureted hydrogen.

This process gives results of remarkable precision, but requires that the liquid should be exempt from chlorides and sulphates; if they happen to be there, it will be necessary to expel the chloride by nitrate of silver, and sulphuric acid by nitrate of barytes, before pouring in the nitrate acid of bismuth.

NOTES ON THE RECENT PROGRESS OF AGRICULTURAL SCIENCE.

BY D. A. WELLS, TROY, NEW YORK.

The following Notes, compiled from various publications—American and foreign—will, it is believed, be found interesting and valuable, as showing the recent progress of agricultural science, both as regards facts and opinions :

DEMANDS OF AGRICULTURE UPON SCIENCE.

The following views in relation to the demands of agriculture upon science were expressed by Professor Vöelcker, of the Cirencester College, England, in a recent address before the Royal Agricultural Society. He believes that among the landed proprietors, their agents, and the larger farmers, especially the rising generation, a more extensive knowledge of the sciences applicable to agriculture is needed. "All these want better instruction. But to teach the small farmer or the laborer chemistry is simply absurd. To either, the pursuit would be waste of time. So chemistry should never be made the direct guide to the agriculturist. Science is, after all, only the systematic arrangement of well-authenticated facts, and the rising generation should be taught its general principles. But many professors of chemistry have over-estimated their own powers, and instead of explaining the experience of practical men, they set themselves up as guides to the farmers; they have over-estimated the powers of the new science, and in consequence stumbled."

Again he says : "Agricultural chemistry, in its application to farming, is altogether a new science ; and hitherto it has been, like every new knowledge, too vague and too general in its doctrines, as well as in its researches. What is required at the time are, experiments made for a special purpose, researches carried on in the field as well as in the laboratory. We have no need of the joint labors of practical men and men of science. There are questions

which can only be properly investigated if the man of science heartily joins with the practical man, working cheerfully together, each in his own department—a nearer approach between agriculture and science, in short, is what is required at the present time. A general knowledge of the principles of farming, however useful to the practical farmer, never will help him to grow a large crop of turnips; he must have special training in practical matters in order to be a successful farmer. So it is with chemical knowledge. Men may have excellent general chemical knowledge in relation to farming, their labors will be of little direct utility to the agriculturist."

In reference to the culture of root crops, he says that, generally, ammoniacal manures, such as guano, are thrown away on roots, and phosphates are more profitable. Guano and super-phosphate of lime both rather retard the germination of the seeds, but they push forward the young plant in its early growth. This we believe to form the true value of such manures, though perhaps this is over-estimated.

THE MACHINERY OF AGRICULTURE.

This is a branch of mechanical arts which requires the careful consideration of the mechanician and the engineer. The time appears to have arrived when the introduction of machinery, combined with the wide diffusion of education, is absolutely required amongst our agricultural population; and in my opinion increased intelligence, together with new machinery, will double the production of the soil, and improve the climate in which we live. Much has already been done, yet very much is yet to be accomplished; we must persevere in the new process of deep draining and subsoil ploughing and in the substitution of steam power in place of horse and manual labor, before we can realize such large and important advantages as are now before us. Great changes and improvements have been effected in my own time by the introduction of new implements to relieve the labors of the farm. Everything cannot, however, be done by the mechanician and engineer; much has to be done by the farmer in the preparation of the land to render it suitable for machine culture, and a willing heart as well as a steady hand is required of the agriculturist before he can work for the public good in concert with the engineer. The reaping machine has now attained such a degree of perfection as to bring it into general use on lands prepared for its reception; and the steam plough is making rapid strides towards perfection, and is likely to take the place of horses, and effect a change as beneficial to the farmer as it will be advantageous to the public at large.—(*William Fairbairn.*)

MACHINE FOR DOING UP WOOL.

A machine for doing up wool, invented and practically tested by Mr. James Geddes, of Fairmount, Cortland county, New York, seems worthy of the attention of wool-growers. An apparatus has been for some time in use, consisting of a box or trough, about three feet long, ten inches deep, and ten inches wide, (on the inside,) placed on legs at a convenient height. Near one end is a stationary head or cross-piece, (attached to a piece of plank sliding in the bottom, and held down by cleats,) which is drawn toward the other by a strap and foot-lever. Slits in these cross-pieces allow three strands of wool twine to be laid along the trough. These are confined at one end by passing through holes in the bottom of the trough, and at the other by being drawn into saw-slits. The fleece is folded on a table to just that point which fits it for the ordinary process of being rolled up by hand, then laid in the trough, and, by pressure on the lever, squeezed or shoved together to the smallest practicable bulk. In the improvement of Mr. Geddes, instead of attaching the strap which draws forward the movable head to a foot-lever, it is attached to a roller of, say, three inches diameter, on an iron shaft placed under the bottom of the box and forward of the stationary head. A ratchet-wheel and dog holds the movable head where it is drawn. By means of suitable straps and rollers, a backward motion of the crank carries back the movable head after the fleece is tied up. It requires but very little effort to turn the crank. The machine, for which no patent has been taken, can be made for about $7.

IMPROVED HORSESHOE.

A patent has recently been granted for a device for relieving the feet of horses from the concussion to which they are liable in passing over pavements.

It consists in combining with the shoe a layer of India-rubber and what is called hoof-plate, the rubber being placed between the shoe and the hoof-plate, and the hoof-plate attached to the foot. By this arrangement, while the rubber is removed from contact with the foot, and is so secured as to be permanent and durable, its elasticity is at the same time made available.

IMPROVED CORN KNIFE, OR TREE PRUNING KNIFE.

An improvement in the construction of a corn knife, or tree pruning knife, consists in an iron attachment to the end of the handle, which is made to reach up along the under side of the arm nearly to the elbow, where it is loosely buckled. This gives all the strength and leverage of the fore-arm to relieve the strain upon the wrist.

IMPROVED HOOK FOR A WHIFFLE-TREE.

An improved hook for a whiffle-tree, from which the trace never can get loose, however slack it may be, while in use ; while it is also as handy to hitch and unhitch as one of the ordinary kind, is a new and successful contrivance. This hook is attached to the whiffle-tree by an iron strap, and plays loosely up and down, turns quite round behind the whiffle-tree, where alone the trace can be hitched and unhitched. As soon as it slips from that position the hook fits close to the iron at every other point, whether pulled tight or left slack. Naturally, where the trace is slack, the hook falls and hangs by its own gravity below the whiffle-tree ; but it is almost, if not quite, impossible that it should turn round upon the rear side so as to unhook.

NEW CORN CUTTER AND SHOCKER.

A novel agricultural implement for cutting and shocking corn has been brought out during the past year. The machine is about eight feet wide, and drawn by two horses. It cuts the standing maize by means of vibrating knives, like those of a mower, and throws it over backward on to a scoop-shaped platform, where the butts are properly arranged by an assistant who stands behind the driver, and has a suitable long-handled hook for the purpose. The tops of the stalks lie in a pair of arms, and when enough have accumulated—say, one hundred to one hundred and fifty hills—to make a shock, they are compressed by means of a rope and windlass, a binding string is tied around them, and the shock is first raised upward and carried backward by a lever which raises a section of the platform, and then tilted up so as to be discharged on the ground, right side up. The machine then drives on, and repeats the same operation. It requires two horses to draw the shocker, and three men to work it.

PREVENTION OF THE RUSTING OF NAILS.

The rusting (and consequently loosening) of nails, employed to fasten the branches of fruit trees to walls, can be prevented in a great measure by driving into the walls, at the same time with the nail, and in contact with it, a small piece of zinc. Nails were recently shown to the Agricultural Society, Ghent, Belgium, which had been eight years in walls in contact with zinc, and which were not at all rusty.

ON THE CONSTRUCTION OF CISTERNS.

The attention of the French Academy has been directed by M. Grimmand to the plan followed in Venice for the construction of cisterns ; and he recommends it strongly to the attention of those whom it may concern.

There are in Venice over two thousand cisterns, which supply the city with pure, good water. Their construction may be briefly stated as follows : In the first place, a hole is dug about ten feet deep, (the nature of the soil at Venice prevents a greater depth,) and in the shape of an inverted truncated pyramid. The earth surrounding the sides is kept in its place by a strong wooden frame, which covers also the bottom of the cistern. Upon this is applied a layer of fine, well-compacted clay, the thickness of which is in proportion to the size of the cistern, but never over a foot. It is considered very important to have no cavities whatever in this layer. On the middle part of the bottom is laid a circular stone, hollowed out in the centre. On this is erected a hollow cylinder, of the diameter of an ordinary well, built of dry bricks, well laid, those at the bottom being pierced with conical holes. This cylinder comes a little above the level of the soil. The space between the cylinder and the clay walls of the pyramid is filled with well-washed sand up to the level of the clay walls. Before covering the whole with the pavement, there is laid at each angle a sort of stone box, the cover of which, also of stone, is pierced with holes. These boxes, called *cassetoni*, are joined with each other by a small canal of dry bricks, resting in the sand. When it rains the water enters by the *cassetoni*, penetrates into the sand by the joint-

ures of the bricks of the canals, and finds its level in the interior of the cylindrical well, having passed through the little holes at the bottom. A cistern so constructed is said to give very pure water, and to retain it perfectly to the last drop.

THE STEAM PLOUGH.

The following review of the present and future of the steam plough, by a writer in the New York World, (October, 1860,) contains much that is worthy of consideration on the part of those who are engaged in perfecting this important, but yet "embryotic" invention:

"Why is the plough imperfect? Simply for the reason that the soil, to be perfectly prepared to receive the seed and produce a crop, should be thoroughly pulverized, deeply dug, and rest on a soft bottom underneath, which last, though not penetrated by the instrument which has worked above it, shall still admit the roots of whatever grows above to enter and run down, if they choose to do so, and draw whatever nutriment they can from below. In short, if land is ploughed six, eight, or ten inches deep, and its upper strata be lifted and turned over to either of those depths, the lever power which raised it is exerted to the same extent to press down still more compactly than before the soil beneath it. That is, the plough, in its work, presses both ways, down as well as up; whereas the work, for the benefit of cultivation, should be lifting only. The pressure down is all wrong, and, so far, does a positive injury to the subsoil, let the comminution of that above be ever so perfect. In light soils we admit that the downward pressure is not always prejudicial to the future crop. But in clay or heavy soils it must be so. The subsoil surface of the furrow below is as polished, from the pressure of the plough upon it, as the top of the inverted earth which is lifted from it and turned over into the adjoining furrow; so, unless the roots of the growing crop be very strong, they must seek their food only near the surface, or within such depths as the plough may have penetrated, and thus be liable to be cut short by drought. For perfect cultivation these difficulties must be obviated.

"Well, and how? By the invention of a rotary digger; that is to say, a cylinder revolving a shaft supported at each end on a frame, on the principle of a common farm or garden roller—that cylinder to be filled with spiked or claw-formed teeth; and, by its rapid revolutions, these teeth must dig up the ground six to twenty inches deep, as may be desirable, leaving the ground light, free, and thoroughly pulverized, to receive the seed of whatever kind. A drill may be attached behind it, for the purpose of sowing or planting the seeds, if necessary. This, in short, is the grand desideratum which we look for in the perfect cultivation of the soil. The earth, by this operation, will be loosened as far down as the machine goes, and the subsoil, beneath what is loosened, will not be packed still harder than it laid before, as with the plough. It will be readily seen that, in this proposition, the plough is superseded entirely, as it should be in all free soils, and an instrument of altogether another kind has to take its place.

"Now, can this implement be invented and perfected for practical and easy operation? We think so. It need be no more complicated than a reaper or a mowing machine. It may be made to work by either horse or steam power.

"Can the small farmer use such a machine economically, even if it be invented and perfected? We believe so, if his land be free from stones and roots. Its probability and compactness will render it easy to manage, and the celerity with which he can get in his crops by its aid will enable him to clear his land from impediments to its working which the dilatory and only partial labor performed by the plough would not. The great advantage of such a machine, however, would be in the vast prairie cultivation of the western States, on broad river bottoms, and in large fields, where the surface lies smooth, free from stones or other impediments, and where a timely cultivation and deposit of the seed is indispensable to successful cropping. Sugar and cotton lands, as well as those for corn, wheat, and other grains, will be immensely benefitted by this rapid cultivation."

THE REAPING MACHINE KNOWN TO OUR CELTIC FOREFATHERS.

Truly, there is "nothing new under the sun!" A correspondent of the *Gloucester Chronicle* thus writes as to reaping machines: "It may, perhaps, be interesting to you and to your readers to learn that those 'utter barbarians,' as our British ancestors have been wont to be called, were before us in many of the inventions which are supposed to be the result of modern ingenuity. I am not prepared to say that they had the steam plough, but that they had reaping machines there can be no doubt in the minds of those who read the following much overlooked passage of Pliny, who wrote between the years 60 and 70 of the Christian era:

"'*De Messe et Tritico.*—Messis ipsius ratio varia, Galliarum latifundiis, valli prægrandes

dentibus in margine infestis duabus rotis per segetum impelluntur, jumento in contrario juncto ita direptæ in vallum cadunt spicæ.' "

Of reaping itself there are various methods. In the broad plains of the Gauls enormous machines, with teeth set in a row, placed on two wheels, are driven through the standing corn, a horse being attached to it in a contrary way to the usual mode of attaching horses. Thus the corn, being cut off, falls into the furrow.—*Pliny's Natural History, Book* 18, *chap.* 30.

Some question may arise whether we would translate *vallum* as it occurs in the latter part of this sentence differently from the sense given that word at the beginning, *vallus* being a van or machine, (see Ainsworth's Dictionary,) and *vallum* being a trench or furrow. If we adopt the latter translation, then it follows that our ancestors had already attained that excellence in their machines which was with such difficulty effected in these of modern construction. If, on the other hand, we translate it as the machine itself, then they had accomplished that which our modern inventors have not yet succeeded in; for they must have made the machine not only to reap, but to carry away the corn.—*From the London Engineer, No.* 241.

THE FORCES USED IN AGRICULTURE.

Mr. J. C. Morton, in a paper read before the London Society of Arts, remarks: "Agriculture is experiencing the truth taught in the history of all other manufactures—that machinery is, in the long run, the best friend of the laborer. This truth is taught even more impressively by a review of agriculture than by the case of any single farm. Here are twenty-one millions of people, producers and consumers, living on this island, (England, Scotland, and Wales,) as it were, on a great farm, which we may, by the help of such statistics as we possess, describe as nearly 19,000,000 arable acres, and probably nearly as much grass, employing as farm labor, in-door and out, about 950,000 men and 120,000 women, besides 300,000 lads and 70,000 girls, or, averaging them by their probable wages, as has been done before, let us say equal in all to 1,500,000 horses, of which probably 800,000 are strictly for farm purposes. We are annually inventing and manufacturing labor-saving machines at an extraordinary rate, and every year at least 10,000 horses are added to the agricultural steam power of the country, certainly displacing both animals and men to some extent. We have taken the flail out of the hand of the laborer, and the reaping hook is going; on many a farm he no longer walks between the handles of the plough; he no longer sows the seed: he does but a portion of the hoeing and the harvesting; and yet, so far from being able to dispense with his assistance, he is more in demand than ever.

"Within the past ten years upwards of 40,000 horse power has been added to the forces used in agriculture in steam alone in Great Britain. In the harvest of 1859 in Great Britain 4,000 reaping machines were probably at work, capable of cutting more in a day than 40,000 able-bodied laborers; and yet labor during all this period was in demand, and wages, instead of decreasing, advanced.

"That the services of the agricultural laborer will more and more require the combination of skill with mere force, and that a larger number of well-qualified men is being and will be needed, seems plain. That horse power will be displaced by steam at least two fifths, I believe; and in this direction there is scope enough for many years to come for all our agricultural mechanics. Furthermore, it is plain that if we can take a considerable proportion of the mere labor of the farm out of the hands of the laborer, and put it into the hands of steam power for its performance, there is an enormous amount of saving to be made in the cost of agricultural production. It is plain that it is mere folly in the laborer to think that, as regards the *mere* labor of the land, he can compete with either steam power or with horse power. Strength of body is desirable, and sinew hardened by long practice in hard labor has a considerable marketable value, for that, however hardly it may sound, is the aspect of the matter in which the interests of the laborer most directly appear; but it is plain that for sheer lift and the mere putting forth of force, horse power, and still more that of untiring steam, must grind the soul out of anybody that shall pretend to competition with them. It is in the cultivation not so much of mere strength of body as of skill and intelligence that the safety of the laborer lies, and in his capability of education he is perfectly secure."

SCIENTIFIC AGRICULTURE IN FRANCE.

M. Demond, director of the Agricultural School of Orleans, (France,) received at the late National *Concours* of Agriculture in Paris, a gold medal for details of his agricultural experiments, and for his method of conducting the agricultural portion of his school. M. Demond makes agriculture one of the bases of a general education. His exhibition was very exten-

sive, and he has published in a pamphlet the result of his experiments. He first endeavored to ascertain the relative value of various manures. He sowed the same species of wheat with thirty-two different manures on thirty-two pieces of land, each receiving $25 worth. For two years the yield of wheat was noted, and the facts derived from the experiments show that the classification of manures by English chemists, according to the amount of nitrogen which they contain, is entirely illusory. It will be remembered that Liebig, in his late letters, comes to the same conclusion. His experiments showed also that wheat sown broadcast, at the rate of two bushels per acre, yielded better than one bushel per acre drilled, and that two bushels and a half sown broadcast yielded less than two bushels sown in the same way. Eight species of wheat drilled, at the rate of three pecks per acre, gave a larger yield than at the rate of a bushel per acre. These experiments show that different soils require a different amount of seed, and that experiments are necessary upon each variety of soil. M. Demond recommends the culture of the six-rowed barley. He finds the culture of sorgho better than that of wheat by a hundred dollars per acre.

COMPRESSED FODDER.

An ingenious invention has just been adopted by the French Minister of War for the better feeding of cavalry horses when on the march. M. Naudin, veterinary surgeon of the Imperial Guard, has succeeded in compressing the food for the journey into small tablets, like those already in use composed of vegetable food for the army. M. Naudin has given publicity to his process, and it is destined, no doubt, to render immense service to the commissariat departments in every country. The hay and straw are chopped fine, the oats and corn crushed, and then mixed in proportion to the nutritive qualities afforded by each. Upon the mixture is poured a mucilaginous residue of linseed, and the whole is pressed and comes out in a hard cake, only requiring to be dried in the oven. Although invented for the emergencies of war, this method of preserving fodder may be found most valuable in reducing the space occupied by the food of cattle on board ship, in distant encampments, or in the long marches of emigration parties. At any rate, the method is a valuable extension of Chollet's invention, and has been eagerly adopted for the provender of the French cavalry of the army of Italy.—*Journal of the Society of Arts, London, No.* 347.

VALUE OF IMPROVED FARMING.

At the meeting of the British Association for the Promotion of Science, in Glasgow, 1859, Mr. Harvey presented the following statistics, showing the money value of the results of improved farming in the county of Aberdeenshire, Scotland, for the interval between 1798 and 1858. Thus:

	£	s.	d.
The live stock value of 1858 exceeds that of 1798 by	1,681,941	5	0
The grain crop by	689,095	6	1
The green crop by	621,454	16	3
The grass crop by	436,956	2	6
Total	3,429,447	9	10

This amount reduced to federal currency, by allowing five dollars to the pound, is upwards of seventeen millions of dollars.

ICELANDIC METHOD OF TYING HORSES.

Barrow, in his visit to Iceland, mentions a curious but effectual plan in practice among the Icelanders for tying horses, which is believed to be peculiar to the Island. They tie the head of one horse to the tail of another, and the head of this one to the tail of the former. Under these circumstances, if the animals are disposed to move, it will only be possible in a circle, and even then there must be an agreement to turn their heads the same way.—*American Stock Journal.*

NUMBER OF HORSES IN THE WORLD.

The general estimate has been eight to ten horses in Europe for every hundred inhabitants. Denmark has forty-five horses to every hundred inhabitants, which is more than

any other European country. Great Britain and Ireland have 2,500,000 horses; France 3,000,000; Austrian Empire, exclusive of Italy, 2,600,000; Russian, 3,500,000. The United States have 5,000,000 horses, which is more than any European country. The horses of the whole world are estimated at 57,420,000.—*Goodrich.*

FATTENING FOWLS.

If it is desired to fatten fowls in a very short time, they should be confined in small coops. Baily says: "A coop for twelve fowls (Dorkings) should be 30 inches high, three feet long, and 22 inches deep. It should stand about two feet from the ground, the front made of bars about three inches apart; the bottom also made of bars about an inch and a half apart, to insure cleanliness, and made to run the length of the coop, so that the fowl constantly stands, when feeding or resting, in the position of perching; the sides, back, and top may be made the same, or the back may be solid." Some writers think it better to make half of the floor a little inclined, and to cover it with a board. Troughs for feed and water should be fastened around the edge of the coop, and the whole placed in an out-building, as a barn or shed, away from other fowls. For the first twenty-four hours give water, but no food. On the second day commence feeding regularly three times daily with the most nutritious food, such as oatmeal mixed with milk, boiled wheat, &c. The troughs should be cleansed daily and plenty of fresh water given; and the fowls must be fed very early in the morning, and all they will eat at all times. In from fourteen to twenty days they will be in their best condition, when they should be killed, for, if kept longer, they soon become diseased.

Poultry may be fattened quicker and more perfectly by stuffing, but it is an unnatural as well as inhuman practice, and we cannot recommend it.—*New York Country Gentleman.*

WASH YOUR PIGS.

Pigs are not dirty when they have any encouragement to be clean. Ours are washed every week in warm soap and water, and well scrubbed behind the ears and everywhere, to their great ease and comfort. A highly economical remark of my man about this part of his work was, that he scrubbed the pig on washing days, because the soap-suds did just as well for manure after the pig had done with them, "and that," said he, "makes the soap serve three times over."—*Our Farm of Two Acres.*

WORMS IN HORSES.

The ascarides make frequent and dangerous attacks on the large intestines, and often cause great disorders. So long as the health of the animal is good, there is no occasion for uneasiness, as one or two worms will be seen in the dejections, especially if they are long white worms. But if they are numerous it becomes necessary to give it medicine.

	Gramme.
Emetic wine	3.33
Spirits of turpentine	19.80
Flax oil	582.00

These substances must be well mixed. A pill composed thus must be administered to it daily for a week.

	Gramme.
Sulphate of iron	1.66
Powdered ginger of gentian	3.33
Powder of piment	1.66
Ginger	1.66

A pill may be made of these with treacle, and it will have a good result.—*From "Journal de la Société d'Agriculture de Belgique."*

CINDERS FOR PIGS.

A long experience has taught me that pigs are very fond of coal ashes or cinders, and that you can hardly fatten pigs properly on boarded floors, without giving them a moderate supply daily or occasionally. In the absence of coal ashes, burned clay or brick dust is a

good substitute. If you do not supply ashes they will gnaw or eat the brick walls of their sheds. I leave to science to explain the cause of this want. It is notorious that coal-dealers, where pigs have access to the coals, are generally successful pig-feeders. Those who find that their pigs when shut up do not progress favorably will do well to try this plan. A neighbor of mine found that a score of fat pigs consume quite a basket of burned clay ashes daily. We know that there is abundance of alkali in ashes. I wish some of your practical correspondents would communicate their experience on this matter, and I also want them to state how many pounds of barley-meal it takes to make one stone of pork not dead weight. It will tend to elucidate the question of profit on feeding stock, as raised in your leading article of the 20th of August.

J. J. MECHI.

NEW BREED OF SHEEP.

A report has lately been made to the Society of Acclimation of Animals, in London, of a new breed of sheep, or at least animals resembling sheep, except in size, found in countries adjacent to the Punjaub. These animals are called Purik Sheep, and are the most diminutive of the *ovis* family, the full grown ones being not larger than lambs of a few weeks old. The Purik Sheep has small bones, a fleshy carcase, and the mutton is excellent, and yields three pounds a year of very fine wool. The ewes generally give two lambs a year. The great advantage of this over other breeds is its domestic habits, living around the cottages as quiet as a house dog, and feeding upon all sorts of waste garbage, scraps of fruit, vegetables, crumbs of bread, shreds that are frequently wasted, eating them from the hands of any one who offers. It is thought that the Purik Sheep would be suited to the climate of England, and exactly adapted to the wants of many cottagers. If so, it would also suit many in this country. It would be a great object to get an animal to consume the kitchen garbage less objectionable than the hog, and the flesh of which would afford a more wholesome food to the common people, too many of whom live, so far as meat is concerned, almost exclusively upon pork.

ON THE DOMESTICATION OF THE SOUTH AMERICAN OSTRICH.

The Bulletin of the Société d'Acclimatation, France, publishes a note from Dr. Vavasseur on the subject of the Nandou or South American ostrich, and on the means of bringing it into a domestic state, and accustoming it to the climate of France. The South American ostrich, although of the same natural family as those in Africa and elsewhere, differs from them by being of rather smaller stature, and by having three toes on the feet, instead of two. They live in numerous bands in the part of South America comprised, from north to south, between the frontiers of the Brazils and Patagonia, near the straits of Magellan, and from east to west between the Atlantic and the Cordilleras of the Andes. They only frequent the open plains, and never enter into the wooded parts of the country. They are commonly found in the plains of the republic of Uruguay, but are very rare in Paraguay. They generally move about in bands of ten and sometimes twenty females, with a single male, which walks generally at their head, and is, besides, readily distinguishable by his larger size. They may be seen seeking their food in the midst of horses and cattle, with which they are always on the best terms. In Uruguay and in Buenos Ayres, where these birds are seldom hunted, they show no alarm at man, but come and feed close to houses; but if they see one or two horsemen approach, as if to surprise them, they run off with extreme swiftness.

The American ostrich is a very quiet and even stupid bird, and its name, "aveztruz," is liberally applied, particularly by the women, to any one who does not evince much intelligence. Although of a generally pacific character, the male ostriches sometimes have battles to defend their own females, or to capture some from other bands, and they then give each other most furious kicks; but their movements on these occasions are ridiculously awkward. The force, however, of their kick is enough to break a man's leg, and such accidents have sometimes occurred. Their laying season is in the month of August; their nest consists of a large hole in the ground, which they do not make themselves, but use those which the bulls make with their fore feet in order to cover themselves with a cloud of dust, which is a favorite custom of those animals. The number of eggs generally found in these large nests is from twenty-five to thirty, but it is not uncommon to find from sixty to eighty. It is thought that all the females belonging to one band lay in the same nest. It is not true, as has been stated, that these eggs are hatched by the heat of the sun, for both the males and females have been sitting on them, but more frequently the former. The flesh of the young ones is good, though rather strong; but that of the grown birds is disagreeable. The eggs, however, form a very good article of food, and are sought after by the country people for

that purpose. The food of the ostriches consists of insects, seeds, and sometimes of small reptiles, such as small lizards, &c.; but they are in general so voracious that they will swallow anything; and pieces of leather, iron, &c., have been found in their stomachs. The young ostriches may be readily tamed.

They must not be placed in a cage, but allowed to walk about, attaching something to their feet to prevent their going too far. They are fed with little bits of fresh meat, which they will take from the hand. They will walk about round the houses, enter into all the rooms, look with apparent curiosity at what is going on, and occupy themselves with catching flies, of which they are very fond. As they grow larger, they go further from their home, but they never fail to return at the time when they are usually fed, or at night to roost. They are very fond of sugar, and will follow a person about to procure it. Dr. Vavasseur concludes by stating that the South American ostrich would live without difficulty in the north of France; that there is no difficulty in domesticating it; that it will feed on anything that is given to it, however coarse; that it is of a very strong constitution, and but little sensible to atmospheric changes; and that it scarcely requires any care, space and liberty being all that is wanted. The advantages which might be derived from domesticating this bird would consist in its feathers, which are in great demand; and from the eggs, which would form a good article of food to the people in the country.

NOTES ON THE ANIMALS OF THIBET AND INDIA.

The following communication on the animals of Thibet and India has been made to the British Association by Mr. R. Schlagintweit, who, with his brother, has recently returned from a scientific exploration of Central Asia.

The existence of the Yak or Thibetan ox in a wild state has been repeatedly doubted, but we frequently found wild yaks. The chief localities where we met with them were both sides of the range which separates the Indus from the Sutlej, near the origin of the Indus, and near the environs of Gartok; but the greatest number of them was at the northern foot of the high Karakorum range, as well as to the south of the Kuenluen, in Turkistan. In western Thibet, particularly in Ladak, there are no more yaks in a wild state at present, though I have no doubt that they have formerly existed there. They seem to have been extirpated here, the population being, though very thin, a little more numerous than in Thibet in general. As Ladak has been occasionally more visited by travellers than any other part of Thibet, the want of the yak here has probably given rise to the idea that they are no more to be found in a wild state at all. Amongst all quadruped animals the yak is found at the greatest height; it stands best the cold of the snowy mountains, and is least affected by the rarefied air. But at the same time the range of temperature in which a yak can live is very limited; the real yak can scarcely exist in summer in heights of 8,000 feet. We often found large herds of wild yaks—from thirty to forty—in heights of 18,600 to 18,900 English feet; and on one occasion we traced them even as high as 19,300 feet, a remarkable elevation, as it is very considerably above the limits of vegetation, and even more than 1,000 feet above the snow line. The hybrid between the yak and the Indian cow is called Chooboo, and it is very remarkable that the chooboos are fertile. The chooboos, which are most useful domestic animals to the inhabitants of the Himalayas, are brought down to lower places, where yaks do not exist, and where, consequently, they cannot mix either with yaks or with the Indian cow. We had occasion to see and examine the offspring of chooboos as far as the seventh generation, and in all these cases we found the later generations neither much altered nor deteriorated; and we were moreover informed that there was never found any limit as to the number of generations. The Kiang or wild horse has been often confounded with the Gorkhar or wild ass, though they differ considerably in appearance, and inhabit countries with very dissimilar climates. The kiang exists in the high cold regions and mountains of Thibet, the ass in the heated sandy plains of Sindh and Beloochistan. The kiang is found in great numbers nearly in the same localities as the yak; he does not, however, go up the mountains so high as the yak, but the range of his distribution is greater than that of the yak. The greatest elevation where we found kiangs was 18,600 English feet, whilst we traced yaks as high up as 19,300 feet. The regions where the yak and the kiang are found are, in a zoological point of view, altogether one of the most remarkable and interesting of our globe. The highest absolute elevation coincides here, it is true, with the greatest height of the snow line, or rather it causes the snow line to be higher. But those large, high plateaus and regions, though free from snow and ice in summer, remain a desert throughout the year. The amount of vegetation on them is less than it is in the Desert between Suez and Cairo, in Egypt. Nevertheless these high, sterile regions are inhabited by numerous herds of large quadrupeds; and besides those already mentioned, numerous species of wild sheep, antelopes, and a few canine animals, chiefly wolves, as well as hares, are abundant. The herbivorous animals find here their

food only by travelling daily over vast tracts of land, as there are only a few fertile spots, the greater part being completely barren.

The gorkhar or wild ass, an animal which, as I mentioned before, has been often confounded with the kiang or wild horse, inhabits chiefly the rather hilly districts of Beloochistan, part of the sandy plains of Sindh, and it is to be found, if I am not mistaken, to the westward of Beloochistan, in Persia, where it is called koolan. Dr. Barth lately told me that, according to the description I gave him, he thinks the asses he saw in Africa identical with the gorkhars or wild asses of Sindh and Beloochistan. I will now try to give an explanation about the fabulous Unicorn, or animal which is said to have one horn only. This animal has been described by Messrs. Huc and Gabet, the famous travellers in Eastern Thibet, according to information they received, as a species of antelope with one horn placed unsymmetrically on his head. When my brother Hermann was in Nepaul he procured specimens of horns of a wild sheep (not of an antelope) of very curious appearance. At first sight it seemed to be but one horn placed on the centre of the head; but on closer examination, and after having made a horizontal section of the horn, it was found to consist of two distinct parts, which were included in a horny envelope, not unlike to two fingers put in one finger of a glove. The animal when young has two separate horns, which are, however, placed so close to each other that the interior borders begin very soon to touch each other; later, by a slight consequent irritation, the horny matter forms one uninterrupted mass, and and the two horns are surrounded by this horny substance, so that they appear at first sight to be but one.

ON THE FEEDING AND GROWTH OF THE AMERICAN ROBIN.

The following communication by Professor Treadwell, of Cambridge, Massachusetts, to the Boston Society of Natural History, giving a detailed account of the feeding and growth of the American robin, contains much that is highly suggestive to those who regard birds as a cost and a nuisance.

When caught the two birds experimented on were quite young, their tail feathers being less than an inch long, and the weight of each about twenty-five pennyweights less than half the weight of the full grown bird; both were plump and vigorous, and had evidently been very recently turned out of the nest. He began feeding them with earthworms, giving three to each bird that night; the second day he gave them ten worms each, which they ate ravenously; thinking this beyond what their parents would naturally supply them with, he limited them to this allowance. On the third day he gave them eight worms each, in the forenoon; but in the afternoon he found one becoming feeble, and it soon lost its strength, refused food, and died. On opening it he found the crop, gizzard and intestines entirely empty, and concluded, therefore, that it had died from want of sufficient food, the effect of hunger being perhaps increased by cold, as the thermometer was about 60°. The other bird, still vigorous, he put in a warmer place, and increased its food, giving it the third day fifteen worms; on the fourth, twenty-four; on the fifth, twenty-five; on the sixth, thirty; on the seventh, thirty-one worms. They seemed insufficient, and the bird appeared to be losing plumpness and weight. He began, then, to weigh both the bird and its food, and the results were given in a tabular form. On the fifteenth day he tried a small quantity of raw meat, and, finding it readily eaten, increased it gradually to the exclusion of worms; with it the bird ate a larger quantity of earth and gravel, and drank freely after eating. By experiment, it appears that though the food was increased to forty worms, weighing twenty dwt., on the eleventh day the weight rather fell off; and it was not until the fourteenth day, when he ate sixty-eight worms, or thirty-four dwt., that he began to increase. On this day the weight of the bird was twenty-four dwt.; he therefore ate forty-one per cent. more than his own weight in twelve hours, weighing after it twenty-nine dwt., or fifteen per cent. less than the food he had eaten at that time; the length of these worms, if laid end to end, would be about fourteen feet, or ten times the length of the intestines. To meet the objection that the earth-worm contains but a small amount of solid nutritious matter, on the twenty-seventh day he was fed exclusively on clear beef, in quantity twenty-three dwt.; at night the bird weighed fifty-two dwt., but little more than twice the amount of flesh consumed during the day, not taking into account the water and earth swallowed. This presents a wonderful contrast with the amount of food required by cold-blooded vertebrates, fishes and reptiles, many of which can live for months without food; and also with that required by mammalia: a man, at this rate, should eat about seventy pounds of flesh a day, and drink five or six gallons of water. The question immediately presents itself, how can this immense amount of food required by the young birds be supplied by the parents? Suppose a pair of robins, with the usual number of four young ones—these would require, according to the consumption of this bird, two hundred and fifty worms, or their equivalent in insects or other food, daily; suppose the parents to work ten hours, or six hundred minutes, to procure this supply, this would

be a worm in every two and four-tenths minutes; or each parent must procure a worm or its equivalent in less than five minutes during ten hours, in addition to the food required for its own support. He was unable to reconcile this calculation with actual observation of robins, which he had never seen return to their nests oftener than once in ten minutes. After the thirty-second day, the bird had attained its full size, and was intrusted to the care of another person during his own absence of eighteen days; at the end of that period the bird was strong and healthy, with an increase of weight, though its feathers had grown longer and smoother. Its food had been weighed daily and averaged fifteen dwt. of meat, two or three earth-worms, and a small quantity of bread each day; the whole being equal to eighteen dwt. of beef or thirty-six dwt. of earth-worms; and it has continued to eat this amount until the present time. The bird having continued, in its confinement, with certainly much less exercise than in the wild state, to eat one-third of its weight of clean flesh daily, he concludes that the food it consumed when young was not much more than must always be provided by the parents of wild birds. The food was never passed undigested; the excretions were made up of gravel and dirt, and a small quantity of white semi-solid urine.

He thought every admirer of trees might derive from these facts a lesson, showing the immense power of birds to destroy the insects by which our trees, especially our apples, elms, and lindens, are every few years stripped of their foliage, and often many of them killed. The food of the robin while with us consists principally of earth-worms, various insects, their larvae and eggs, and a few cherries; of worms and cherries they can procure but few, and these during a short period, and they are obliged to subsist principally upon the great destroyers of leaves, canker-worms, and some other kinds of caterpillars and bugs. If each robin, old and young, requires for its support an amount of these equal to the weight consumed by this bird, it is easy to see what a prodigious havoc a few hundreds of them must make upon the insects of an orchard or park. Is it not, then, to our advantage, he asks, to purchase the services of the robins at the price of a few cherries? There has lately been some improvement in preserving our birds, and with a little more protection he thinks such an increase of them might be obtained as would save us from all the labor required for the appliances of tar, oil, zinc plates, and all other methods by which we seek, with very imperfect success, to destroy our mischievous insects.

ON THE FOOD OF BIRDS.

At a recent meeting of the French Academy—the Academy of Sciences of Paris—it was reported that Mr. Prévost, one of the gentlemen attached to the Jardin des Plantes in that city, has, after several years' labor, ascertained with certainty the different descriptions of food on which European species of birds live at different periods of the year. The report establishes one "great fact" which is specially interesting to farmers, and that is, that birds, generally speaking, do far more good to crops than harm, inasmuch as the number of insects they destroy greatly exceed the quantity of grain they eat. The same thing has been proclaimed before, but a scientific demonstration of its truth is not the less acceptable.

IMPROVEMENT IN THE TREATMENT OF BEES.

At a late meeting of the Linnean Society, Mr. Tegetmeir described a practical application of Shirach's discovery of the power possessed by bees of raising a queen or female bee from neuter grubs, by means of which the contents of old hives can be taken without destroying the bees, or *sacrificing any brood.* The plan consists in driving out the queen and about half the bees in spring, and establishing them as a new swarm, when the bees remaining in the old hive have to raise a new queen from a worker grub. From the time required to accomplish this, it follows that no eggs can be laid in the hive for about three weeks. By this time all the worker-producing eggs laid by the old queen will have been hatched out and the cells filled with honey, when the whole of the bees are to be driven out, and the honey, which by this means will be found perfectly *free from brood,* retained for use. Mr. Tegetmeir added that the plan had been very successfully worked out at the bee-house of the Apiarian Society, and exhibited specimens of the result to the meeting.

BEE-KEEPING.

Chloroform has been applied instead of sulphur to bees. A correspondent in the *Edinburg Evening Courant* has adopted this plan successfully. The quantity of chloroform required for an ordinary hive is the sixth part of an ounce; a very large hive may take nearly a quarter of an ounce. His mode of operation he describes as follows: "I place a table opposite to and about four feet distant from the hive; on the table I spread a thick linen cloth; in the centre of the table I place a small shallow breakfast plate, which I cover with a piece

of wire gauze, to prevent the bees from coming in immediate contact with the chloroform. I now quickly and cautiously lift the hive from the board on which it is standing, set it down on the top of the table, keeping the plate in the centre; cover the hive closely up with cloths, and, in twenty minutes or so, the bees are not only sound asleep, but, contrary to what I have seen when they are suffocated with sulphur, not one is left among the combs; the whole of them are lying helpless on the table. You now remove what honey you think fit, replace the hive in its old stand, and the bees, as they recover, will return to their home. A bright, calm, sunny day, is the best; and you should commence your operations in the morning before many of the bees be abroad.

ON THE TEMPERATURE OF THE BEE-HIVE IN WINTER.

Upon this subject naturalists have differed greatly in opinion. Réaumur states that during the season when the country furnishes no food for bees, they do not require to eat; the cold which deprives our fields and gardens of their flowers renders the bees torpid, in which state no transpiration takes place. Swammerdam, Huber, and others state, on the contrary, that bees do not become torpid in winter, but that even in frosty weather a full hive can maintain a temperature of 86 or 88 degrees of Fahrenheit.

This interesting question remained in this condition until a few years ago, when Mr. Newport (who has enriched the science of entomology with some splendid discoveries) instituted an extensive and profound inquiry into the subject of the temperature of insects. He had long suspected of incorrectness the opinion that the hive is able to maintain a high temperature in winter, a circumstance so much at variance with the habits of insects in this country that, were it so, the hive bee would form a singular exception to the general economy of insects. The only method, as it seemed to Mr. Newport, of arriving at this truth, was to make such arrangements as would enable him at any time, during many months, to ascertain at a glance the internal temperature of the hive. He placed a common straw hive with its entrance hole in the direction of another wooden hive, which was standing beside it in a bee-house so constructed that the whole of the back part of the house could be removed or closed at pleasure. The proper entrance for the bees at the front of the bee-house was directly into the wooden hive, from the side of which there was a little covered communication with the entrance hole of the straw hive, to serve as a passage for the bees, and a connexion between the wooden and straw hive. The object of this was to prevent any sudden effect upon the temperature of the hive by changes which might occur in the temperature of the air without. The interior of the straw hive was thus subjected as little as possible to the variations in the open atmosphere, since the bees were obliged to pass through the empty wooden hive before they could reach the open air. In order to make the experiment with the greatest accuracy, it was necessary that the bees should never be disturbed while making an observation; and therefore a small thermometer, with a long free bulb, was passed through a hole just large enough to admit it in the top of the straw hive, about eight inches from the centre, and retained there during the whole of the subsequent observations without being removed or touched. The bees at first seemed a little inconvenienced by its presence, but within two or three days they became accustomed to it, and removed the comb and wax from around it, so that the bulb of the instrument was remaining about an inch within the free space of the hive, and the observations were then made at intervals with the greatest accuracy. The temperature of the atmosphere was taken with a thermometer similar to the one used for the hive. It was thus only necessary to notice from time to time the rise and fall of each thermometer, and the difference between them, the temperature of the air being of course taken in the immediate vicinity of the bee-house.

By this course of observation it was found that the hive bee during winter does not become absolutely torpid; but, if left entirely undisturbed, it passes into a condition in which its temperature of body and amount of respiration become very greatly diminished—a state of deep sleep in the combs, from which, by a beautiful provision of nature, it is roused by great cold. As soon as the temperature falls considerably, the insect shakes off its torpor and commences breathing with energy, by which an amount of animal heat is produced which exerts its salutary influence on the air of the hive. It is only at a moderate temperature that the insects continue torpid, and, when in this state, it is very easy to rouse them from it by gently shaking or tapping the hive. When this is done in winter, the bees wake up, become excited, and soon, by the rapidity of their respirations, raise the temperature of the hive to a great height. In the case of Huber and others, who did not observe the scientific precautions of Mr. Newport, the thermometer was introduced into the hive at the time of making the observation, thereby disturbing the bees, and exciting them to increased vital energy, and consequently to increased animal heat. The effect of a sudden disturbance of bees is strikingly shown in the following observation: On the morning of the 2d of January, 1836, at a quarter past seven, when there was a clear, intense frost, and the

thermometer in the open air stood a little above 17 degrees, that in the hive marked a temperature of 30 degrees; that is actually two degrees below the freezing point. The bees were roused by tapping on the hive, and in sixteen minutes the mercury rose to 70 degrees, or 53 degrees above the external air.

It was found by a long course of observation that the temperature of the hive, when the bees are in a state of repose, varies with that of the atmosphere; but that the change within the hive is never so rapid as in the atmosphere, unless the bees have been disturbed. When the external temperature rises very suddenly, it never exceeds that of the hive by more than one or two degrees, provided the bees are in a state of absolute rest; but if, on the contrary, the temperature of the atmosphere be suddenly diminished, that of the hive will subside also, but much less rapidly. Sometimes the two thermometers stand exactly equal to each other. On the other hand, when the bees are active and respiring quickly, the hive is even then affected in the winter months by great changes in the temperature of the external air, particularly if such changes occur late in the autumn or at the beginning of winter.

But a change in the atmosphere in summer does not so rapidly affect the temperature of the hive; because in summer, when the general warmth of the atmosphere ranges from 45 degrees and upwards, the bees are always active, and are not themselves so readily affected by sudden changes; while in winter, when the temperature ranges from 45 degrees downwards, the bees are very soon affected by diminished heat, and become disposed to pass into the torpid state, in which scarcely any respiration takes place, and the temperature of the little animals sinks down, or nearly so, to that of the medium in which they are placed, and even to that of the external atmosphere, if there is communication with it. Each bee is probably, in general, from 10 to 15 degrees warmer than the medium in which it lives when in a state of moderate excitement, but its heat is liable to be greatly increased from causes which will be noticed in another article, on the temperature of the hive in summer.

It has been already shown that a surprising amount of heat may be suddenly developed in the hive, even in midwinter, by exciting the bees. In a second straw hive, which Mr. Newport had exposed to the open air like the common cottage hives, the internal temperature at ten oclock a. m. of the 2d of February was a little over 48 degrees, being only 14 degrees higher than that of the external atmosphere. On disturbing the hive by tapping, the mercury rose to 102 degrees, or 68 degrees above the temperature of the surrounding air. When the heat is thus suddenly increased during the earlier or latter part of winter, it becomes intolerable to the bees, and they immediately endeavor to reduce it by ventilation, provided the outer cold be not too severe to prevent their assembling near the entrance of the hive. At about 40 degrees the temperature of the hive is quickly modified by the assiduity of the bees. "I have often," says Mr. Newport, "been amused by observing them, after the hive has been disturbed for a short time, although but a few minutes before there was not a single bee on the alighting board, come hastily to the entrance of the hive, and, having arranged themselves within three-quarters of an inch of the doorway, begin to fan with their wings most laboriously, to occasion a current of cool air through the interior of the hive." On one occasion, when the temperature of the hive had been raised to about 70 degrees, the external air being at 40 degrees, the bees at mid-day maintained the temperature steadily at 57 degrees by their mode of ventilation, the hive continuing at the time to be excited.

Although the hive be very much disturbed, and its temperature become greatly increased by exciting the bees in midwinter, it will soon become quiet again and its temperature be again reduced to within 10 or 12 degrees of the temperature of the atmosphere within about ten hours.

CHINESE MODE OF TAKING HONEY.

Mr. Fortune, the well-known English botanist, thus describes the mode adopted by the Chinese for taking honey from bee-hives. He says: "The Chinese hive is a very rude affair, and looks very different from what we are accustomed to use in England; yet, I suspect, were the bees consulted in the matter, they would prefer the Chinese one to ours. It consists of a rough box, sometimes square and sometimes cylindrical, with a movable top and bottom. When the bees are put into a hive of this description it is rarely placed on or near the ground, as with us, but is raised eight or ten feet, and generally fixed under the projecting roof of a house or out-building. No doubt the Chinese have remarked the partiality which the insects have for places of this kind, when they choose quarters for themselves, and have taken a lesson from this circumstance. My landlord, who had a number of hives, having determined one day to take some honey from two of them, a half-witted priest, who was famous for his prowess in such matters, was sent for to perform the operation. This man, in addition to his priestly duties, had charge of the buffaloes which were kept on the farm attached to the temple. He came round in high glee, evidently considering his qualifications of no

ordinary kind for the operation he was about to perform. Curious to witness his method of proceeding with the business, I left some work with which I was busy, and followed him and the other priests and servants of the establishment to the place where the hives were fixed. The form of the hives, in this instance, was cylindrical; each was about three feet in height, and rather wider at the bottom than the top. When we reached the spot where the hives were placed, our operator jumped upon a table placed there for the purpose, and gently lifted down one of the hives and placed it on its side on the table. He then took the movable top off, and the honeycomb, with which the hive was quite full, was exposed to our view. In the meantime an old priest, having brought a large basin, and everything being ready, our friend commenced to cut out the honeycomb with a knife made apparently for the purpose, and having the handle almost at right angles with the blade. Having taken out about one-third of the contents of the hive, the top was put on again, and the hive elevated to its former position. The same operation was repeated with the second hive, and in a manner quite as satisfactory. But, it may be asked, 'Where were the bees at this time?' and that is the most curious part of my story. They had not been killed by the fumes of brimstone, for it is contrary to the doctrines of the Buddhist creed to take away animal life; nor had they been stupified with fungus, which is sometimes done at home; but they were flying about over our heads in great numbers, and yet, although we were not protected in the slightest degree, not one of us was stung; and this was the more remarkable as the bodies of the operator and servants were completely naked from the middle upwards. The charm was a simple one; it lay in a few dry stems and leaves of a species of Artemisia, (wormwood,) which grows wild on these hills, and which is largely used to drive that pest, the mosquito, out of the dwellings of the people. This plant is cut early in summer, sun-dried, then twisted into bands, and it is ready for use. At the commencement of the operation which I am describing, one end of the substance was ignited, and kept burning slowly as the work went on. The poor bees did not seem to know what to make of it. They were perfectly good-tempered, and kept hovering about our heads, but apparently quite incapable of doing us the slightest injury. When the hives were properly fixed in their places, the charm was put out, and my host and his servants carried off the honey in triumph."

ON THE PRODUCTION OF SEXES AMONG SHEEP.

The following article, communicated to the *Journal d'Agriculture Practique*, by M. Martégoute, furnishes information of value and interest to those engaged in the breeding of sheep:

The interesting researches of Giron de Bazareingues into generation, and particularly on the production of the sexes among domestic animals, are now known but by very few persons, having the misfortune to be of too remote a date. On the other hand, meeting with a varied reception on their appearance, they have had the fate of all contested things—they have left in the mind nothing but ideas undecided as to their value. Zootechny, in fact, was too little advanced at that period for the art of animal production to think of extracting from such a study facts for its use.

Daily observations, conducted and arranged with the calculation in hand, in a sheepfold of great importance—that of the Dishley-Mauchamp merinos, of M. J. M. Viallet, at Blanc, in the commune of Gailhac-Toulza, (Haute-Garonne)—have enabled me to comprehend the laws which, according to M. Giron de Bazareingues, preside over the production of the sexes.

The general law which Giron de Bazareingues recognized on the subject of the procreation of the sexes is as follows: The sex of the product would depend on the greater or less relative vigor of the individuals coupled. In many experiments, purposely made, he has obtained from the ewes more males than females, by coupling very strong rams with ewes either too young or too aged, or badly fed; and more females than males by an inverse action in the choice of the ewes and rams he put together.

This law has developed itself regularly enough at the sheepfold of Blanc, in all cases in which circumstances of different vigor between the rams and ewes have been observed in coupling them. Witness two striking examples of it:

In 1853, births, the issue of young ewes by a Dishley-Mauchamp merino ram, extremely vigorous and highly fed, produced twenty-five males, and nine females only, or 71.73 per cent. of males, and 28.27 per cent. of females.

At a later period the same ram, still in full vigor, having been put to some ewes that had done nursing their lambs—a period at which the ewe is found very weak—there resulted, in 1853, eight male births against four females; and, in 1854, under similar circumstances, seventeen male against nine female births. The two occasions united yielded 65.78 per cent. of males, and 34.22 per cent. of females.

But the following fact has nothing in common with those related by Giron de Bazareingues,

and which has been repeated, with small variation, every year from 1853, the period at which the observations I have noted down began.

This fact consists, 1st. In that, at the commencement of the rutting season, when the ram is in his full vigor, he procreated more males than females.

2d. When, some days after, the ewes coming in heat and in great numbers at once, the ram was weakened by a more frequent renewal of the exertion, the procreation of females took the lead.

3d. The period of excessive exertion having passed, and the number of ewes in heat being diminished, the ram also found less weakened, the procreation of males in majority again commenced.

In order to show that the cause of such a result is isolated from all other influences of a nature to be confounded with it, I shall take the years 1855–'56, in which, by the effect of a degree of equilibrium of age and vigor between the rams and ewes, the male and female births were found, relatively with each other, nearly upon a par in numbers, being 25 males to 23 females.

The following table, drawn up with the dates of birth, exhibits the facts in detail. The letter M indicates the male and F the female births.

It will be seen that, the list of births having been divided into three successive series, and in mean proportions almost equal, we have for the first, of eleven days, from the 27th December to the 8th January, 13 males against 4 females; for the second, of nine days, from the 9th to the 18th January, 3 males only against 15 females; and for the third, of eleven days, from 19th to 29th January inclusive, 9 males against 4 females.

Table of the Dishley-Mauchamp Merino Lambing, at the sheepfold of Blanc, in December and January, 1855–'56.

FIRST SERIES.

December 27	M.	January 4	M.	January 6	M.
30	M.	4	M.	7	F.
31	M.	4	M.	8	M.
January 3	M.	5	M.	8	M.
3	F.	5	M.	8	F.
3	F.	6	M.		

Males, 76.8 per cent.; females, 23.9 per cent.

SECOND SERIES.

January 9	F.	January 13	F.	January 16	F.
9	F.	15	F.	16	F.
11	M.	15	F.	16	F.
12	F.	15	M.	17	F.
12	F.	16	F.	18	M.
13	F.	16	F.	18	F.

Males, 16.66 per cent.; females, 83.24 per cent.

THIRD SERIES.

January 19	M.	January 20	M.	January 24	M.
19	M.	20	F.	24	M.
19	F.	22	F.	29	M.
19	F.	22	M.		
20	M.	23	M.		

Males, 69.23 per cent.; females, 30.77 per cent.

At the end of each month all the animals of the Blanc sheepfold are weighed separately; and, thanks to these monthly weighings, we have drawn up several tables, from which are seen the diminution or increase in weight of the different animals, classed in various points of view, whether according to age, sex, or the object for which they were intended.

Two of these tables have been appropriated to bearing ewes, one to those which have borne and nursed males, and the other to those that have borne and nursed females. The abstract results of these two tables have furnished two remarkable facts.

1st. The ewes that have produced the female lambs are, on an average, of a weight superior to those that produced the males, and they evidently lose more in weight than these last during the suckling period.

2d. The ewes that produce males weigh less, and do not lose in nursing so much as the others.

If the indications given by these facts come to be confirmed by experiment sufficiently repeated, two new laws will be placed by the side of that which Giron de Bazareingues has determined by his observations and experiments.

On the one hand, as, at liberty or in the savage state, it is a general rule that the predominance in acts of generation belongs to the strongest males to the exclusion of the weak, and as such a predominance is favorable to the procreation of the male sex, it would follow that the number of males would tend to surpass incessantly that of the females, amongst whom no want of energy or power would turn aside from generation, and the species would find in it a fatal obstacle to its reproduction. But, on the other hand, if it was true that the strongest females, and the best nurses amongst them, produce females rather than males, Nature would thus oppose a contrary law, which would establish the equilibrium, and, by an admirable harmony, would secure the perfection and preservation of the species by confiding the reproduction of either sex to the most perfect type of each respectively.

ON THE ORIGIN AND DISTRIBUTION OF SPECIES IN PLANTS.

Dr. Hooker, of England, in a recently published work on the "Botany of the Antarctic Voyage," in discussing the relations and distribution of species in plants, lays down the following propositions as axioms:

"1. That all the individuals of a species have proceeded from one parent, (or pair,) and that they retain their distinctive (specific) characters. 2. That species vary more than is generally admitted to be the case. 3. That they are also much more widely distributed than is usually supposed. 4. That their distribution has been effected by natural causes; but that these are not necessarily the same as those to which they are now exposed."

"Hybridization has been supposed by many to be an important element in confusing and making species. Nature, however, seems effectually to have guarded against its extensive operation and its effects in a natural state, and, as a general rule, the genera most easily hybridized in gardens are not those in which the species present the greatest difficulties."

"With regard to the facility with which hybrids are produced, the prevalent ideas on the subject are extremely erroneous. Gärtner, the most recent and careful experimenter, who appears to have pursued his inquiries in a truly philosophical spirit, says that 10,000 experiments upon 700 species produced only 250 true hybrids."

"It would have been most interesting had he added how many of these produced seed, and how many of the latter were fertile, and for how many generations they were propagated."

"The most satisfactory proof we can adduce of hybridization being powerless as an agent in producing species, (however much it may combine them,) are the facts that no hybrid has ever afforded a character foreign to that of its parents, and that hybrids are generally constitutionally weak and almost invariably barren. Unisexual trees must offer many facilities for the natural production of hybrids, which, nevertheless, have never been proved to occur, nor are such trees more variable than hermaphrodite ones."

ON A SOURCE OF DISEASE FOR CATTLE.

M. Isidore Pierre has detected butyric acid in soils, stagnant waters and drainings from dung-heaps, and considered its presence the cause of the death of some horses who drank water containing its salts. Butyric acid (so called from its being first noticed as produced from butter) is the result of the fermentation of saccharine substances when the presence of lime or other alkali prevents the formation of alcohol, and when the fermentive process is prolonged beyond the stage at which lactic acid is generated. As saccharine matter is found in nearly all cultivated plants, its presence in farm-yard pools is easily accounted for; and if the butyric acid, to which it gives rise, really does form poisonous salts, the matter deserves the serious attention of agriculturists. M. Pierre does not appear to have obtained any positive evidence of this supposed action, but to have assumed it because no other cause of the death of the horses in question and of the illness of others could be discovered.

PRESERVATION OF FOOD.

A new method of preserving animal and vegetable substances has been recently patented at Paris by means of immersion into a solution of gum tragacanth and gelatine, in the proportions of one pound of the former to six ounces of the latter, with the addition of twelve ounces of acetate of alumina. These ingredients are dissolved in water, and kept boiling for

twenty-four hours, in order to insure their intimate mixture. The meat, &c., after being washed and cleansed from all blood or other extraneous matters, is dipped into the hot solution, and moved about in it for the space of two minutes; and when withdrawn it must be exposed to the open air for a day and a night, in order to dry the coating it has acquired in the solution, which, if not dry, would decompose. This operation may be repeated two or three times, if it be thought desirable to form a thick coat over the substance which it is intended to preserve.

EFFECTS OF BRINE IN FOOD.

Last year, in consequence of accidents arising out of the use of brine in food, the Council of Health of Paris inquired into the subject. The following is from their report: "The use of brine as a condiment or seasoning in the nutriment of man has hitherto had no injurious effect, and nothing authorizes the opinion that an economical process so advantageous for the poor should be proscribed. The same is not true of the abuse which is made of this substance in the nourishment and in the treatment of the disease of certain animals, especially swine and horses. Authentic facts and recent experiments show that the mixture of brine in considerable quantity with food may produce real poisoning. In all cases brine preserved too long, or in contact with rancid meat, should be employed with the greatest care, and after it has been purified by skimming off all the scum which forms on the surface."

MEANS OF DETERMINING THE QUALITY OF MILK.

The following is an abstract of a paper recently read before the Chemical Society of Dublin, Ireland, on the above subject, by Dr. H. Minchin:

"The practical difficulty which has attended the employment of the several methods of milk-testing hitherto in use is to be attributed, in some measure, to the fact that upon any scale that can be devised, upon any principle whatever, there is not one point to which we can refer as a standard of purity. The nearest approach we can make to the establishment of such a standard is to ascertain, by experimenting on several specimens of average quality and known purity, whether we can seize upon some physical property which admits of sufficiently accurate measurement for the purpose; then it has been ascertained that an inferior quality is indicated when the specific gravity is below a certain range; but this can be raised artificially by the abstraction of some of the cream. An inferior quality is also indicated when the percentage of cream is less than a certain number; but the instrument for this is fallacious, as it only shows how much cream has floated to the surface in a given time, and experiment has proved that the richer the milk the less is the cream disposed to float. Many persons can judge pretty accurately as to the quality of milk by carefully observing the transparency of the fluid when poured in a thin film from one vessel to another; and this property, which has already suggested the instrument of M. Donné, might be again turned to account in the construction of a more simple instrument, which would indicate definitely, and enable us to register numerically, the degree of transparency possessed by a given sample; and we should thus have a very efficient means of estimating the degree to which the milk had been diluted, or it fell short of the average quality.

"Such an instrument has lately been invented; the principle of its construction is extremely simple, and the experiments instituted with a view of testing its performance, several series of which have been repeated, appear to have been attended with the most satisfactory and encouraging results. The instrument was made of brass, in the form of a shallow, oblong vessel, capable of containing about an ounce of fluid; the depth of the vessel is made to increase gradually, by means of a slab of white enamel fixed in a gentle slope from one end to the other. This slab is graduated throughout its entire length. Upon this the milk is poured till the vessel is filled, and a cover of plate glass is then put on; this should be done by giving it a sliding motion, to exclude air bubbles. When the vessel full of milk is thus covered, the degree of dilution possessed by the sample under examination is estimated by the number of degrees on the enamel which can be read through the glass cover; for, the glass being in contact with the edge of the enamel plate at one end, and separated from it by a gradually increasing interval towards the other, the intervening stratum of milk is made to assume the form of a thin wedge. If the fluid under examination be of a rich quality, abounding in oily and caseous particles, it will possess such an amount of opacity that only a few degrees can be discovered on the subjacent enamel when the instrument is held opposite to the light. If, on the contrary, the specimen be of inferior quality, whether from innate poverty or the admixture of water, the diminution of opacity thence resulting will be evinced by the enamel scale becoming visible through a deeper part of the fluid or at a greater distance from the commencement of the scale. The degree of translucency, therefore, can be measured by the number of lines visible through the fluid.

BLUE MILK.

Dr. E. Reichard, of Jena, Germany, relates a remarkable instance of *blue milk*, which occurred in that vicinity, within a circle of several miles, during the fall of 1859. The milk, and especially the cream, after standing for some time, assumed a blue color, and the cause for this anomaly could not be attributed either to the food, want of cleanliness, or influence of locality.

A careful examination into the facts, chemical as well as microscopic, disclosed the presence of a specimen of *mould*, most likely the *Byssus coerulia*, Lam. The coloring appeared at first to centre in a few isolated spots, and from them to spread through the cream downwards, and the fibres of the plant could easily be removed with a pincette for microscopical examination. This accords fully with the results of Braconnot and Bailleul, Lehman and Fuchs, but refutes the theory of E. Jones, who ascribes the blue color to an abnormal amount of phosphate of iron, as well as that of Klaproth, who derives its origin from indigoferous plants. Vallot states that some authors ascribe this circumstance to the feeding on such plants as *Hyacinthus comosus, Butomus umbellatus.*

ON THE OCCURRENCE OF POISONOUS METALS IN CHEESE.

At the last meeting of the British Association, (1860,) Professor Voelcker stated that he had recently been able to detect both copper and zinc in English cheese.

In some specimens copper, in others zinc, and in some both copper and zinc, were found. The description of cheese in which these poisonous metals were found was double Gloucester cheese. Skimmed-milk cheese, which was likewise examined for copper and zinc, did not contain any metallic impurity. Stilton, and other varieties of cheese, have not as yet been examined. It must not, therefore, be inferred that cheese made in other districts than Gloucestershire contains poisonous metals. Inquiry in the dairy districts of Gloucestershire and Wiltshire has led to the discovery that in many dairies in these counties sulphate of copper, and sometimes sulphate of zinc, are employed in the making of cheese. The reasons for which these prejudicial salts are added to the cheese are variously stated. Some persons added sulphate of zinc with a view of giving new cheese the taste of old; others employed sulphate of copper for the purpose of preventing the *heaving* of cheese. Dr. Voelcker also stated that he had found alum in Gloucester cheese, and mentioned that he had learnt that in some dairies alum was employed to effect a more complete separation of the caseine from the whey.

INFLUENCE OF THE MOON ON THE WEATHER.

At the Leeds meeting of the British Association, 1858, Mr. Harrison presented a paper "On the influence the moon exerts on temperature," and he claimed that the following points must be regarded as established meteorological facts:

1. That the temperature before the first quarter is lower than that of the second day after it.
2. That this fall and rise prevails most in the winter months, and in the month of May.
3. That a reciprocity of action takes place between corresponding days of the moon's age.

Thus, whilst it was found, both at Dublin and Greenwich, that for twenty-one consecutive years the mean temperature rose at the first quarter in more instances than it fell; it fell at the last quarter in more instances than it rose; and in the only two years in which a fall occurred instead of a rise at the first quarter, there was a rise instead of a fall at the last quarter.

Between new and full moon this reciprocity of action was still more apparent. Here, for the same series of years, there was a fall in thirteen years after new moon, and a rise in thirteen years after full moon; and in five out of the eight instances in which a rise occurred instead of a fall at new moon, a fall instead of a rise took place at full moon. Also a like principle appeared to hold good in individual months. For example, in twenty-one consecutive Januarys, a fall occurred in seventeen at new moon, while a rise took place in sixteen at full moon. The action thus apparent at different periods of lunation was shown clearly in curves of temperature of each day of the moon's age.

A curve of ten years' mean temperature at Greenwich, for 1837 to 1846, was exhibited in juxtaposition with one sent to the Dublin meeting, which was also formed of ten years' mean temperature, at the latter station, for 1847 to 1856. At first and last quarters the curves corresponded in a most remarkable manner at both stations. At new and full moon they alternated—the fall in the Dublin curve being at the new moon, and the rise at full moon; in the Greenwich curve the rise at new moon, and the fall at full moon. Leaving the consideration of daily mean temperatures, on extracting the maxima and minima mean tempe-

ratures for the month, it was found that more maxima occurred after first quarters than before, the proportion of maxima to minima, on the *second* day after that phase, being more than twenty-one, both at Dublin and Greenwich, for the respective periods of twenty-two and forty-three years. The twenty-four highest and lowest maxima and minima in the month, at Greenwich, were then taken for the same forty-three years; forty-eight per cent. found to occur at first quarter, and *minima only* before the day of the change. Similar results were obtained from the highest and lowest mean temperatures at Dublin and at Toronto, from 1843 to 1848.

Another point elicited during the progress of the inquiry was the recurrence of high and low temperatures on the same days of the lunation. Taking first the maxima and minima mean temperatures for the month during twenty years at Greenwich, from 1837 to 1856, the whole number found recurring on corresponding days (many of them three and four times in each period of twelve lunations) amounted to 236, averaging about twelve for each year, or half the maxima and minima for the month.

To illustrate this recurrence of high and low temperatures, several years were selected which presented the strongest evidence of system. Thus, in the two consecutive years commencing November, 1847, and ending October, 1848, maxima and minima occurred—in 1847 twice on the third day before new moon, twice on the second day before new moon, three times on the day after new moon, twice on the third day after new moon, three times on the second day before full moon and twice on the third day after full moon. In 1848, three times on the day of new moon, twice on the day after new moon, three times on the second day before full moon twice on the day before full moon and twice on the fourth octant or fourth day after full moon.

In the same years there were also, among many others, the following remarkable instances of reciprocity between opposite phases of the moon: In December the minimum for the month occurred on the third day before new moon; in January the maximum on the third day before full moon; in February the minimum on the third day before new moon.

And, again, the maximum in September fell on the day after full moon; the minimum in October on the day after new moon. "In addition to this, the maxima and minima for the month were found to occur at intervals of rather more than seven, fourteen, or twenty-one days, and that for several successive months, viz: April, May, June, August and September, and so in other years."

In 1838, exactly ten years earlier, maxima or minima occurred three times on the third day after new moon, three times on the day after full moon, three times on the day of first quarter and three times on the day of last quarter—that is to say, in twelve instances out of twenty-four, *on four days of the lunation.*

At the Cape of Good Hope reciprocity of action and the recurrence of high and low temperatures were even more frequent and systematic. Thus, in 1855, eight out of the twelve maxima for the month occurred at first quarter, and nine of the twelve minima at new or full moon. In 1842 nineteen maxima and minima out of twenty-four occurred on eight days. In 1843 fifteen on seven days. In 1844 seventeen on six days. In 1845 eleven on four days.

The recurrence of maxima and minima at Toronto and Madras was equally marked. Mr. Harrison considered that the dispersion of clouds under full moon may now be taken as a fact, on the testimony of Humboldt, Sir J. Herschel, Mr. Johnson, (the Radcliffe observer, at Oxford,) and others; Mr. Johnson having also noticed that this cloud-dispelling power commences about the fourth or fifth day of the moon's age, and lasts till she approaches the sun the same distance on the other side; that is to say, the influence takes place at that time as well as at the full moon, though not necessarily continuously.

Mr. Nasmyth, also, who was considered a valuable witness, from his long-continued observation of the moon for the purpose of mapping its surface, was quoted as having satisfied himself that clouds disappear when the moon is about four days old; and also that, when this is the case for any length of time at new moon, the sky is clouded to a corresponding extent at full moon—another instance of the principle of reciprocity.

Several well-known observers were also mentioned as having noticed the remarkable clearness of the morning of the 13th of September, on the fifth day after new moon; and, lastly, even M. Arago's explanation of the popular notion among gardeners around Paris that the moon which, commencing in April, becomes full in May, destroys their tender plants, it was thought might be quoted as evidence of lunar influence on the atmosphere, though given by him as a simple statement of the effects of terrestrial radiation on early vegetation.

Mr. Harrison, in conclusion, expressed his belief that the remarkable regularity of the recurrence of a fall before first quarter is due to the clearing of the atmosphere at that period, and the rise after first quarter to a more cloudy state of the sky. That the same effect is not so evident on the curves at the period of full moon he considered might be due to the greater reciprocity of action which takes place at the syzygies, or new and full moon.

The president, Mr. Hopkins, observed that the facts Mr. Harrison had adduced must be considered strongly confirmatory of the view he so ably advocated. That the moon exercised an influence upon the weather, and particularly on the formation or dispersion of clouds, was, as all know, a very generally prevailing opinion. The sailors even had a common saying, that the full moon cut up or devoured the clouds; and Sir John Herschel had somewhere admitted that the nights about full moon, particularly at certain seasons of the year, were remarkably cloudless. This indirect influence, then, being admitted, it became more important to trace it, as Mr. Harrison was doing, to an influence upon the temperature.

Some years ago Dr. Foster, an eminent meteorologist of Bruges, announced to the English Astronomical Society that, in weather journals kept by his grandfather, his father, and himself, from 1767 downwards, whenever the new moon fell on a *Saturday*, the following twenty days were wet and windy. The Society published this, the general idea being that the statement had never been made known before. Since then it has been found that the Saturday moon has this character even in popular rhymes, and that it is widely believed in among seamen, English, French, Spanish, and even Chinese.

A writer in the London *Atheneum*, after adverting to this circumstance, and stating that in the one instance in which he had made observations the theory appeared to be confirmed, makes the following suggestive remarks:

"Now, here is a curious circumstance; the whole world has the notion, widely scattered, that a Saturday moon brings wet weather, and science has hardly the means of being kept positive in the negative; and this is only one such case. Curious effects of the moon are in the popular belief by scores; and there is no refutation, except *a priori*—that is, no refutation at all.

"Every twenty-nine and a half days is divided into two periods, one of which has many times as much moonlight as the other. That the moonlight must have a great deal of heat when it leaves the moon is highly probable; that it has none when it reaches the surface of the earth is certain. What then becomes of all the heat, which it seems almost certain the moonlight brings with it? Sir John Herschel thinks that it is absorbed in the upper regions of our atmosphere; and that some probability is given to this supposition by the tendency to disappearance of clouds under the full moon; a fact observed by himself without knowledge of its having been noticed by any one else; and which Humboldt, he afterwards found, speaks of as well known to the pilots and seamen of Spanish America.

"If this theory be correct, there is a cause of weather cycles which must produce some effect; an enormous quantity of heat poured into the atmosphere during one-half of the lunar month, and a very small quantity during the other half. In truth it has been ascertained that the quantities of rain which fall, in the four quarters of the moon, are not quite the same in the long run."

But the popular mind gets hold of the question in a different way. It seizes upon the geometrical phenomena of the moon, nothingness, halfness, fullness, and makes the moments of these appearances, the times at, or very near which, change of weather is to take place. According to the recognized old notions, it is enough if a change of weather takes place within three days one way or the other of a change, which gives twenty days every month, in which a change is set down to the moon. No wonder this theory is often confirmed.

The whole question of moonlight, not position of the moon, both as to its effects on the weather, and its asserted effects on vegetable and animal life, is in the earliest infancy, so far as systematic observation is concerned. All that is said about it is mere infallibility.

SCIENCE OF THE WEATHER.

From a manual recently compiled by Admiral Fitzroy, of England, for the British Board of Trade, we derive the following popular directions "How to observe the weather."

"A few of the more marked signs of weather, useful alike to seamen, farmer and gardener, are the following:

"Whether clear or cloudy—a rosy sky at sunset presages fine weather; a red sky in the morning bad weather, or much wind (perhaps rain;) a gray sky in the morning, fine weather; a high dawn, wind; a low dawn, fair weather.

"Soft looking or delicate clouds foretell fine weather, with moderate or light breezes; hard-edged, oily-looking clouds, wind. A dark, gloomy, blue sky is windy; but a light, bright blue sky indicates fine weather. Generally, the softer clouds look, the less wind (but, perhaps, more rain) may be expected; and the harder, more 'greasy,' rolled, tufted, or ragged, the stronger the coming wind will prove. Also, a bright yellow sky at sunset, presages wind; a pale yellow, wet; and thus by the prevalence of red, yellow, or gray tints, the coming weather may be foretold very nearly; indeed, if aided by instruments, almost exactly.

"Small inky-looking clouds foretell rain; light scud clouds driving across heavy masses, show wind and rain; but if alone, may indicate wind only.

"High upper clouds crossing the sun, moon, or stars, in a direction different from that of the lower clouds, or the wind then felt below, foretell a change of wind.

"After fine clear weather, the first signs in the sky of a coming change are usually light streaks, curls, wisps, or mottled patches of white distant cloud, which increase, and are followed by an overcasting of murky vapor that grows into cloudiness. This appearance, more or less oily, or watery, as wind or rain will prevail, is an infallible sign.

"Usually, the higher and more distant such clouds seem to be the more gradual, but general, the coming change of weather will prove.

"Light, delicate, quiet tints or colors, with soft, undefined forms of clouds, indicate and accompany fine weather; but gaudy or unusual hues, with hard, definitely outlined clouds, foretell rain, and probably strong wind.

"Misty clouds forming, or hanging on heights, show wind and rain coming—if they remain, increase, or descend. If they rise or disperse, the weather will improve or become fine.

"When the sea-birds fly out early, and far to seaward, moderate wind and fair weather may be expected; when they hang about the land, or over it, sometimes flying inland, expect a strong wind with stormy weather. As many creatures besides birds are affected by the approach of rain or wind, such indications should not be slighted by an observer who wishes to foresee weather.

"There are other signs of a coming change in the weather, known less generally than may be desirable, and therefore worth notice; such as, when birds of long flight, rooks, swallows, or others, hang about home, and fly up and down or low—rain or wind may be expected. Also when animals seek sheltered places, instead of spreading over their usual range; when pigs carry straws to their sties; when smoke from chimneys does not ascend readily (or straight upwards during calm) an unfavorable change is probable.

"Dew is an indication of fine weather; so is fog. Neither of these two formations occurs under an overcast sky, or when there is much wind. One sees fog occasionally rolled away, as it were, by wind—but seldom or never formed while it is blowing.

"Remarkable clearness of atmosphere near the horizon, distant objects, such as hills unusually visible, or raised, (by refraction,) and what is called 'a good hearing day,' may be mentioned among the signs of wet, if not wind to be expected.

"More than usual twinkling of the stars, indistinctness, or apparent multiplication of the moon's horns, halos, 'wind dogs,' and the rainbow, are more or less significant of increasing wind, if not approaching rain, with or without wind."

AIR DRAINAGE.

The essential elements of vegetable production that are more or less under artificial control are three—earth, air, and water; and it may be affirmed that a proper regulation of these three elements is all that is necessary in the vast proportion of farms within the temperate zone.

The earth must be alternately and thoroughly air-soaked and water-soaked; and it will ultimately be found that the one greatest use of the soil is to decompose the air, the oxygen becoming fixed by oxydisable substances and the nitrogen absorbed by the living plants. Hence drainage is so necessary, even in dry land, not by promoting the discharge of water *per se*, but by promoting the admission of air, which must rush in and fill the soil that the water is leaving immediately, and with the same velocity and in the same volume.

But, granting these premises, it may be truly alleged that soils vary through a wide range as to their greater or less affinity for oxygen, some being highly oxydisable, others, as to the purely silicious, having scarcely any appreciable attraction for it. Hence the necessity for all kinds of manures, which act not in the way that they are generally supposed, viz, in supplying food to the plants by direct appropriation of the matter of the manure, but chiefly by adding those oxydisable substances to the soil which will promote the decomposition of the air.

Under this view, it is easy to understand how new lands are for a few years generally fertile, but gradually lose their oxydisable appetites and become chemically inert, unless they are rendered active by artificial addition of some compost.

Yet these latter instances are decidedly the exceptional ones, the great majority of our lands suffering from the occlusion of elementary influences, and really possessing all the properties essential to fertility, if they were favorably arranged for the free percolation of air and water.

It is really surprising how extensive is the impression that water is like some deleterious substance or poison to land; and therefore the chief and sole idea of hundreds of farmers is to get rid of it at any price, not reflecting that as is the egress of water so is the ingress of

air, the exchange being effected *pari passu;* and it seems probable that the final purpose of the shower is not merely to afford the essential drink to the living plant, but to displace the stagnant air in the soil and renew it by percolation.

Nearly every field is differently situated naturally with reference to drainage, the different angles of surface inclination, the nature of subsoil, and the character of underlying rocks, whether open or close, or having favorable or unfavorable stratification.—*Farmers'* (*English*) *Magazine.*

DRAINAGE INCREASES THE EFFECT OF MANURE.

Draining not only "deepens the soil," but largely increases the effect of the application of manures.

The elements of manure act upon plants only in a state of solution; hence it is of the greatest importance that they be so applied, and that the soil be so prepared that they may not only be readily dissolved by the rain, but that the rain may freely pass through the soil, which, acting as a filter, arrests and holds these elements where they will best serve as food for vegetation. Manures applied to undrained land are readily dissolved by the rain, but are left floating upon the surface, and thus often pass away by evaporation or in the surface drainage of heavy rains, the saturated subsoil not allowing them to sink to the roots of the plants or to be absorbed by the soil. This is one great reason why manures produce such trifling results on heavy lands, especially in seasons of abundant moisture. In very dry weather but little more effect follows their application from the want of a solvent, such as is ever supplied by the water retained in mellow, porous earth.

"Draining renders the land penetrable to water," says a writer on this subject, "enabling the rain to descend freely through it, carrying to the roots the fertilizing elements with which rain water is always charged," as well as those it takes in solution from manures. The effect of manures is also much increased by an intimate mixture with the soil. Such mixture can be but imperfectly obtained in the case of hard and shallow land, either in a wet or dry state. It will always be found that mellow and friable soils receive most benefit from manures, and that clayey soils, if made mellow by draining, possess the greatest absorbent powers, and are of the most productive character, compared with sandy and light or mucky loams.

"The true policy of the farmer is to use every means in his power for rendering his labor more effectual and his farm more fertile, and in no way can this be better accomplished, in the case of wet and retentive lands, than by draining, and thus deepening and increasing the productive powers of the soil."—*Country Gentleman.*

ADVANTAGES OF DEEP DRAINING.

The following remarks were made at a late meeting of the Surrey (England) Agricultural Association, by an English agriculturist, Mr. Butcher, on receiving a prize for the best practical results of draining:

Entering upon an explanation of his plan of drainage, he avowed himself to be a deep drainer, and to have been so for the last thirty years. He remembered to have been laughed at for placing a main drain 13 feet deep. In the place where he had carried on his operations the surface drainage had been attempted by one after another most unsuccessfully, but the needs still remained just the same, and could not be cured. He, however, having plenty of energy, and the owner placing at his disposal plenty of money, he had succeeded in restoring an estate which had been represented as irreclaimable. He felt pleased that he had succeeded, because the old men of the day gone by were unable to find out the secret. He found it out thus: that while others were content with mere surface drains, he dug deeper and deeper until he came down to the springs. He made a deep main drain, while his general drainage was about four feet, though on coming into the farm he found his neighbors' drainage about two feet. He felt that the land he had drained was drained efficiently. He advised that land should not be drained in small portions, and with furrows; but, even in a clay soil, to allow the moisture to pass quickly through, as if through a colander, without leaving any of it to adhere to the surface. If the water was required to be carried off the surface, it must be done by ploughing on a flat surface; and whatever draining was done on stiff land was required to be done deep. On meadow land it was necessary to be careful, and to drain on a proper system, with the drains not too closely connected; always keeping one consideration in mind—not to study an artificial position, but to take nature's surface; and as nature makes the fall of the land, let the workmen take the cut.

MODEL SYSTEM OF DRAINAGE.

The drainage of the town of Rugby, England, is considered by agricultural engineers as the best that has as yet been constructed. Everything is conveyed by a system of sewers to a given receptacle on the outskirts of the town; and here an enterprising agriculturist, in consideration of a handsome annual bonus, by him paid, takes possession of it, and by means of pipes conveys it to such points of his farm as will enable him to best spread it equally over his land. The result is that he obtains several crops of grass in each year of immense weight and value.

SEWAGE MANURE.—CAN IT BE MADE AVAILABLE FOR AGRICULTURAL PURPOSES?

In the attempts which are being constantly made or proposed, to supply the demand for fertilizing agents, (a demand which, by the exhaustion of soils, consequent on shiftless farming, must annually increase,) attention has been long directed to the immense waste of fertilizing material occurring in large cities and towns, through their system of sewage, by which large quantities of excrementous matter are poured into streams or rivers, and become thus lost to the public forever. It has, for example, been estimated that in the city of New York an amount of fertilizing matter is thus wasted, which, if applied to the soil, would possess a money value of $15,000 per diem, or $5,475,000 per annum. This is at the low estimate of two cents per day for a population of 750,000,* without taking into consideration the products of the immense number of animals kept in the city.

In a letter addressed to the Sanitary Convention which assembled in Boston in 1860, Mr. George B. Emmerson estimated that every family of five persons annually created refuse matter sufficient to manure at least one acre of land; and that the fertilizing matter annually wasted in Boston, by means of its system of drainage, was sufficient to restore 30,000 acres of poor land to fertility.

The following evidence as to the fertilizing value of sewage matters is derived from recent British authorities:

Mr. R. Moffatt, of Stirling, applied the sewage water of that town to grass land, at the rate of 45 carts to the acre, and the result was nearly double that of the land not so manured.

So, near Edinburgh, where that manure is used, there are four cuttings of grass in the year taken from the land.

Mr. Smith, of Deanston, grew 43 bushels of barley per acre on land manured with sewage, and 46 from guano and farm-yard manure. The first, cost 10*s*. per acre; the latter, four times that sum.

The same paper cites many other cases, too numerous for a review to do more than refer to.

The Duke of Portland, at Mansfield—a town having ten thousand or twelve thousand inhabitants—has made very successful experiments with the sewage of that town, which led to the astounding fact that the land there increased in consequence from 6*s*. per acre to £12 or £14. Mr. R. Walker uses with great advantage the sewage of Rugby.

Professor Miller, in his Parliamentary Evidence, said the quantity of potash which passes out of one of the London sewers per day is one ton, and the same quantity of phosphates and magnesia, and of ammonia nearly two tons.

Dr. Daubeny states that the refuse of a family of four amounts in the year to 4,745 lbs., containing 30 lbs. of nitrogen, 10 lbs. of phosphates, and 6 lbs. of potash; and he calculates the annual value of the sewage of London at £635,150. But the calculations of others exceed £800,000.

According to Liebig, 100,000 persons would give 24,440 tons of manure, containing 30.0 of nitrogen, or 738 tons, sufficient to manure 50,000 acres. This, for 2,500,000 persons, would give 608,800 tons of manure, and 18,450 tons of nitrogen, sufficient to manure 1,250,000 acres of wheat land. The value of 738 tons of nitrogen Liebig sets down at $60,000, which, for the larger population, would give $1,500,000 annually; but all these calculations are believed to be underrated.

But, admitting the great value of sewage for agricultural purposes, the practical question which presents itself for solution is simply this: Can the liquid manure of sewers be deprived by any means of the vast quantity of water with which it is diluted, its solid contents thrown down, and so rendered easy of transportation, at a price which shall render it remunerative, providing at the same time that its preparation shall not become a nuisance, and

* The population by the last census is over 800,000, which, at the same rate, will give nearly $7,000,000 per annum.

that the effluvia necessarily arising from large masses of decaying matter shall not be rendered deleterious to the inhabitants?

The composition of sewage, according to Dr. Letherby, an English chemist, is as follows: The clear supernatant part contains a large quantity of amorphous organic matter, with the filaments of various fungi. It swarms with animalculæ, especially after exposure to the air, when the higher infusoria appear. Small particles of animal and vegetable tissues also float in it, as the fibres of wool and cotton. The sediment, which is black and glutinous, consists of the remains of undigested food, with phosphates and other products of the secretions. Living animal forms and vegetable growths are also numerous. The mineral part is composed of the *debris* of the streets, black sulphuret of iron, and other substances.

The plan which readily suggests itself for treating sewage manure is that of deodorizing and precipitating the solid contents by means of some chemical substances. A patent process, which excited some attention in England a few years since, proposed to effect this by means of charcoal and sulphate of alumina, (one of the principal ingredients of alum.)

The amount of water which daily flows into the sewers of London is about sixty millions of gallons, exclusive of rain water. (The individual daily allowance in London is 36, in New York it is above 90 gallons.) By the new process ten grains of sulphate of alumina were required to be mixed with one pint of sewage. This gives four scruples to the gallon, or three and a half pounds weight to each ton of sewage; and as 240,000 tons are delivered daily from the London sewers into the Thames, without the addition of rain, it would require the enormous weight of 146,000 tons of the sulphate of alumina per annum to effect the object proposed, the cost of which, at the rate of seven dollars and a half per ton, (less than the present market price,) would be $2,555,000 per annum. This, without any allowance for charcoal used, or the expense of machinery or manufacture.

Another plan for treating sewage, which has found favor with many, is that of filtering the liquid through beds of pulverized charcoal. This substance, in virtue of its absorbing powers, retains a considerable quantity of the sewage fertilizing material, and is rendered valuable. The practical application of the system would be as follows: Taking a population of 5,000, and assuming the water supply to equal 36 gallons per head per diem, or 5,776 cubic feet, we have a daily supply of 180,000 gallons. Suppose three-fourths of this to be supplied in twelve hours of the day, it would equal 135,000 gallons, or 137½ gallons per minute. Now, for the perfect filtration of ordinary rain water, two square yards of filtering surface are required to clear one gallon per minute; but for extraordinary water, deeply discolored with vegetable matter, five and a half square yards are required to render the same amount of water in the same time colorless. Assuming two square yards of filtering surface sufficient for sewage purposes, it would require a filtering bed of 375 square yards, or rather less than one-twelfth of an acre to clear the above quantity of water. To apply the same system to the sewage of New York would require an area of forty or fifty acres filtering surface. It must also be remembered that the charcoal, to continue operative, must often be renewed, which, on a large scale, would prove impracticable.

A third plan proposed has been to deodorize in part the water, collect it in ponds, or other receptacles, and allow its solid contents to precipitate themselves to the bottom, from which they are afterwards to be collected. The objections to this scheme, which are almost insuperable, are that, for any considerable operation, reservoirs of great area would be required; and when the supernatant water is drawn off, and the deposits at the bottom removed, as they must be periodically, such removal would be not only attended with great expense from the difficulty of handling the materials, but would create a nuisance not to be endured in any populated district. It is, therefore, evident that such reservoirs, if constructed, must be located at a considerable distance from the habitable portion of those districts from whence the sewage is derived. In many places the drainage levels are so arranged that artificial means for transporting the liquid would be required. Any plan of this character for treating sewage materials necessarily presupposes deodorization as the first step. Sanitary considerations, indeed, would imperatively demand this, and no scheme could expect to disarm popular prejudice which did not essentially effect it.

One of the most extensive plans for treating sewage, with a view of rendering it available for manure, hitherto proposed and in any degree carried out, is that of *Mr. Wicksteed*, of England, a somewhat eminent engineer. This gentleman, in 1851, obtained a patent for treating sewage by means of lime and certain mechanical arrangements; and in 1852 an act of Parliament was obtained incorporating the "Patent Sewage Manure Company," with a capital of $500,000, a considerable portion of which was subscribed and paid in.

The company subsequently established works at Leicester of a capacity sufficient to treat the sewage afforded by a town of five thousand inhabitants.

As nothing has been published recently concerning the success of the enterprise, it may be presumed that it was unsuccessful. It may possibly have received a death-blow from the investigations of Professor Way, chemist to the Royal Agricultural Society, (England,) who has proved that while lime is effectual as a deodorizer of sewage, the value to agriculture of

the organic matter precipitated by it is very small, and is more than counterbalanced by the addition of from forty to sixty per cent. of a tolerably useless matter—carbonate of lime.

Professor Way has also shown, in his valuable papers published in the Journal of the Royal Agricultural Society on "Town Sewage," that the principal parts of the substances important to vegetation—the ammonia, the phosphoric acid, and the alkaline salts—are washed out of the solid sewage by the water in which it is held in suspension. He also states that an examination of the solid sewage obtained from the mouth of one of the principal sewers of London showed that it contained less than *four per cent. of ammonia.*

One of the latest plans proposed for utilizing sewage is that brought forward by Mr. J. Mechi, the well known-English agriculturist.

This gentleman "having given up all hopes of obtaining town sewage in a solid form," proposes to pump the entire sewage into elevated reservoirs, from whence it is to be distributed in large main pipes, and conveyed to each proprietor's farm in suitable smaller conduits. The elevation from which the liquid is to flow is to cause sufficient pressure to effect the discharge of the same at the respective farms by means of a jet.

This plan having been sanctioned by a number of highly practical men, the London Commissioners of Sewers submitted the whole subject to an engineer, with instructions to report estimates and an opinion respecting its feasibility. From this official report we make the following extract:

"The quantity of sewage water which will probably be afforded by the city of London in 1860 will amount to at least 102,048,588 gallons per day, or 166,719,190 tons per annum.

"According to the analysis of the eminent chemists, Professors *Brande* and *Cooper*, 150 tons of London sewer-water contains 1-500th part, or 6 cwt. of solid matter, which may be considered a sufficient average quantity for an acre of ground per annum; the solid matter contained in 166,719,190 tons of sewer-water will therefore be equal to 6,668,760 cwt., which, at 6 cwt. per acre, will supply an area of 1,111,460 acres.

"The extent of district to consume it will be rather more than double, or 3,500 square miles—equal to a circle 66½ miles in diameter. The main pipage required will be equal to 1,236 miles, varying in diameter from 38 inches to 12 inches. The steam power required will be equal to 16,152 horses, working under a pressure equal to a column of water of 500 feet. The capital required will amount to nearly 12,000,000 pounds, (60,000,000 dollars.) The quantity of coals required per annum will be about 170,000 tons. The annual cost of coals, labor, stores, repairs for engines, buildings, &c., will amount to 240,000 pounds, (1,200,000 dollars.)

"Supposing ten per cent. upon the capital to be sufficient to cover all disbursements, including five or six per cent. interest upon capital, this will amount to 1,200,000 pounds, (6,000,000 dollars,) which, for 333,438 tons of solid matter, will give a cost of about 18 dollars per ton.

"The foregoing calculation will perhaps be sufficient to convince the Commissioners that the liquid scheme, even if it should be carried out as herein proposed, is not a feasible one; but when, in addition to what has been stated, it is borne in mind that the basis upon which the calculation rests is upon the assumption, first, that the whole of the sewage water could be collected into one central spot; secondly, that twelve 38-inch radial pipes could be laid in straight lines from this central point; thirdly, that a circle of 66½ miles in diameter around London is a flat plain, and the great number of actual hills do not exist; fourthly, that a sufficient number of landed proprietors could be found within the proposed limit to use so large a quantity of one kind of manure; and as the supply must be constant, to construct covered reservoirs on their lands to hold the supply during such periods as it is not being actually poured upon the land, and unless these, to me, impossible conditions can be complied with, the estimate for $60,000,000 will be found much too small. I think the Commissioners will agree with me that such a scheme for the disposal of sewage water should not be entertained."

Notwithstanding this most unfavorable report, Mr. Mechi continues to advocate the use of sewage as a fertilizer, and the distribution of it through pipes and reservoirs throughout the country adjacent to large towns and cities. At a recent meeting of the London Society of Arts, (1860,) he read a paper combating this usual objection, that sewage is too much diluted to be beneficial to agriculture. Thus, he stated, that the manure produced by the live stock on a farm might be taken (reducing all animals to sheep for the sake of calculation) at something less than the manure of two sheep per acre. The average rain-fall showed that the produce of each sheep was diluted with about 1,300 tons of water, while the manure produced by each resident in towns only received about 80 tons of water. The conclusion he arrived at therefore was, that the sewage was in reality sixteen times less diluted, and consequently sixteen times stronger than that on which the farmers of England usually depended for the production of their crops. So that, in fact, an annual application of 160 tons of town sewage per acre would equal the animal manuring which the farms now received.

In this connexion the following extracts from a letter addressed by Liebig (under date of November 17, 1859) to Mr. Mechi on the subject of the "Utilization of the Drainage of Cities for Agricultural Purposes," in response to a communication of the latter, cannot fail to be read with interest:

"It is true that the diligent tillage of the fields, sunshine and timely rain, are the outward conditions, perceptible to all men, of good harvests; but these are perfectly without effect upon the productiveness of the field, unless certain things not so easy of perception by the senses are present in the soil, and these are the elements which serve for nourishment—for the production of roots, leaves and seeds, and which are present in the soil always in very small quantity in proportion to the mass of the soil itself.

"These elements are taken from the soil in the products of the field, in the corn, or in the flesh of the animals nourished by these products, and daily experience shows that even the most fruitful field ceases, after a certain series of harvests, to produce these crops.

"A child can comprehend that, under these circumstances, a very productive field, in order to remain *very* productive, or even simply productive, must have the elements which had been withdrawn in the harvests perfectly restored; that the aggregate of the conditions must remain, in order to produce the aggregate results; and that a well, however deep it may be, which received no supply of water, must in the end become empty, if its water is constantly pumped out. Our fields are like this well of water. For centuries those elements which are indispensable to the reproduction of the field crops have been taken from the soil in those crops, and that, too, without being restored. It has only recently been ascertained how small a supply of these elements the soil really has. A beginning has been made to restore to the fields the loss which they sustain through the annual harvests, by introducing from external sources manures containing the same elements. Only a very few of the better informed farmers perceive the necessity of this restoration, and those of them who have the means have zealously endeavored to increase the amount of these elements in their fields; but by far the greater part of them know nothing of such restoration.

"The loss of these elements is brought about by the 'sewerage system of towns.' Of all the elements of the fields, which, in their products in the shape of corn and meat, are carried into the cities and there consumed, nothing, or as good as nothing, returns to the fields. It is clear that if these elements were collected without loss, and every year restored to the fields, they would then retain the power to furnish every year to the cities the same quantity of corn and meat; and it is equally clear that if the fields do not receive back these elements agriculture must gradually cease. In regard to the utility of the avails of the 'sewerage of towns' as manures, no agriculturist, and scarcely an intelligent man, has any doubt; but as to their necessity, opinions are very various.

"Many are of the opinion that corn, meat, and manures are wares, which, like other wares, can be purchased in the market; that with the demand the price may perhaps rise; but this will also stimulate the production, and that all turns upon having the means to purchase, and so long as England has coal and iron she can exchange the products of her industry for the corn, meat and manure which she has not. In this respect I think it would be wise not to be too confident of the future, for the time may perhaps come, even in half a century, that not one of those countries upon whose excess England has hitherto drawn, will be able to supply her with corn, and that, too, from the natural law that what is true of the smallest piece of ground is true also of a great country—it ceases to produce corn if the conditions of the reproduction of the corn which has been carried off are not restored to it.

"In the United States the population increases at a still greater ratio than in other countries, while the corn production upon the land under cultivation has constantly fallen off.

"History teaches that not one of all those countries which have produced corn for other lands have remained corn markets, and England has contributed her full share towards rendering unproductive the best lands of the United States, which have supplied her with corn, precisely as old Rome robbed Sardinia, Sicily and the rich lands of the African coast of their fertility.

"Finally, it is impossible in civilized countries to raise the corn production beyond a certain limit, and this limit has become so narrow that our fields are no longer capable of a higher yield without an increase of their effective elements by the introduction of manures from abroad. By means of the application of guano and bones, the farmer of most limited capacity learns the real meaning of such increase; he learns that the pure system of stall or home-made manures is a true and genuine robbing system. In consequence of his restoring, in the guano and bones but a small portion of the very same elements of seeds and of fodder which had been withdrawn from his fields by centuries of cultivation, their products are wonderfully increased. Experiments instituted with special reference to this end in six different parts of the kingdom of Saxony showed that each hundred weight of guano put upon a field produced 150 lbs. of wheat, 400 lbs. of potatoes, and 280 lbs. of clover more than was produced by the same sized piece of ground without guano, and from this it may be calculated

how enormously the corn and flesh production of Europe has been increased by the yearly importation of 100,000 tons or 2,000,000 cwt. of guano.

"The effect of guano and bones should have taught the farmer the real and only cause of the exhaustion of his fields; it should have brought him to perceive in what a condition of fertility he might have preserved his fields, if the elements of the guano which he has transported in the shape of meat and products of his fields into the cities, were recovered and brought into a form which would admit of their being restored every year to his fields.

"To an understanding of this, however, the farmer has not yet come; for, as his forefathers believed that the soil of their fields was inexhaustible, so the farmer of the present day believes that the introduction of manures from abroad will have no end. It is much simpler, he thinks, to buy guano and bones, than to collect their elements from the sewers of cities, and if a lack of the former should ever arise, it will then be time enough to think of a resort to the latter. But of all the farmers' erroneous opinions this is the most dangerous and fatal. If it is perceived that no country can perpetually supply another with corn, then must it be perceived that the importation of manures from another country must cease still earlier, since their exportation diminishes the production of corn and meat in that country in so rapid proportions that this decrease in a very short time manifestly forbids the exportation of manures. If it is considered that a pound of bones contains in its phosphoric acid the necessary condition for the production of 60 lbs. of wheat; that if the English fields have become capable, by the importation of 1,000 tons of bones, of producing 200,000 bushels more of wheat in a series of years than they would have produced without this supply, then we can judge of the immense loss of fertility which the German fields have sustained by the exportation of the many hundred thousand tons of bones which have gone from Germany to England. It will be conceived that if this exportation had continued, Germany would have been brought to that point that she could no longer have been able to supply the demand of her own population for corn. In many parts of Germany, from which formerly large quantities of bones were exported, it has already come to be the case that these bones must, at a much higher price, be bought back again in the form of guano, in order to the paying crops of former time.

"The prices of bones have become so high in Germany as to forbid their exportation, and if the question should be put to English commerce whence it furnishes the English farmer with this to him so indispensable manure, the answer would produce astonishment; for this commerce has so far robbed all the inhabited parts of the earth, that the manufacturer of super-phosphate can only set his hopes upon the phosphate lime of the mineral kingdom.

"In relation to guano, I have been assured that in twenty or twenty-five years, if its use should increase in even the same proportion as hitherto, there will not remain in South America enough to freight a ship. We will, however, suppose its supply and that of bones to continue for fifty years, or even longer—then what will be the condition of England when the supply of guano and bones is exhausted?

"This is one of the easiest of all questions to answer. If the common 'sewerage system' is retained, then the imported manures, guano and bones, make their way into the sewers of the cities, which, like a bottomless pit, have for centuries swallowed up the guano elements of the English fields, and, after a series of years, the land will find itself precisely in the condition it was in before the importation of guano and bones commenced; and after England shall have robbed the cultivated lands of Europe even to complete exhaustion, and taken with them the power to furnish her longer with corn and manure, then she will not be richer than before in the means of producing corn and wheat, but will from that time forth become even poorer in these means.

"By the importation of guano and bones the population has, however, in consequence of the increased production of corn and meat, increased in a greater ratio than would have been possible without this importation of manures, and this population will make upon the rulers of the state their natural demand for food.

"It has been maintained that the recovering of the manure-elements out of the sewers in the large cities is impracticable. I am not ignorant of the difficulties which stand in its way; they are, indeed, very great. But if the engineers would come to an understanding with the men of science in relation to the two purposes—the removal of the contents of the sewers and the recovery of their valuable elements for agriculture—I do not doubt that a good result would follow. Intelligence, in union with Capital, represents a power in England which has rendered possible and practicable things of much greater apparent difficulty."

ON THE PHYSICAL PROPERTIES OF SOILS.

The physical properties of soils are more important than their chemical properties.

A few years ago chemical analysis was going to do great things for the farmer. He had only to send a piece of his poor pasture to the chemical laboratory to be told precisely how

to make the rest of it as good as his garden. But it has been found that certain elements, without which the plant cannot perfect itself, may exist in the soil in sufficient quantities for the plant, and yet be beyond the reach of the chemist. Chemical analysis pretends not to find a less fraction than the 1.1000th. An acre of soil, one foot deep, will weigh 2,000,000 lbs.; an ordinary wheat crop will take off only 200 lbs. of mineral matter; allowing one-half of this to be phosphate, and we have only one twenty-thousandth part composed of that element or quantity—too small, it may be, for the chemist to find. Four hundred pounds of guano, containing, say one-fifth phosphates, applied to an acre entirely destitute of phosphates, would make all the difference there is between a good crop and no crop at all. But this eighty pounds, distributed through the two millions of soil, would be too trifling a quantity for the present state of chemical analysis to detect. Besides, this is too expensive for the farmer; nor does he need it, for the general deductions of the chemist are of more value to him than any particular analysis of his soil.

The fineness of the particles in any soil is an important point. A Boston chemist (Mr. Wells) some years ago found an unproductive New England soil had nearly the same mineral constituents as a specimen soil from the Scioto valley, one of the richest localities in the world; but the former was heavy and coarse, while the latter was an impalpable powder, flying away from the slightest breath. It would take a pretty strong breeze to raise some of our New England soils. A soil, too, must have the right elements ready for the crop in a state of solubility as it goes along. The elements may be there, but if the crop cannot get hold of them, they are valueless. Exposure to the atmosphere has a tendency to remedy that. The absorbing power of the soil is great, but this power depends on the minute division of its particles.—*Prof. Johnson.*

SOIL ANALYSIS.

A recent writer in the North British Agriculturist makes the following remarks on the subject of soil analysis:

"To analyze a soil, and determine from the results the degree of its fertility and its adaptation to particular crops, was one of the problems placed before the agricultural chemist, and from its solution the greatest advantages to agriculture were anticipated. *As yet these expectations have not been realized;* nor can this be considered as a matter of surprise.

"The progress of our knowledge, in place of simplifying, has complicated the question, and has shown that the fertility and infertility of a soil is dependent upon a *variety* of circumstances, of which its chemical composition is *only one.* Instances exist in which the barrenness of a soil can be distinctly traced to the deficiency of some one or other of the necessary elements of plant-life; but in other cases a barren and a fertile soil may present an almost perfect similarity in composition, and contain all the elements required by plants in proportions known to be amply sufficient for their healthy growth.

"The difficulty of explaining these facts has been increased just in proportion as soil analyses have become more minute; for their tendency has been to show that the instances in which infertility is due to the *absence* of any of the essential constituents of the plants are comparatively *rare*, and that quantities which we are apt to overlook as totally unimportant may be amply sufficient for all that is required.

"One-tenth of a per cent. of potash, soda, or phosphoric acid may appear a quantity so small that the chemist might be justified in neglecting it; and yet a soil containing these quantities is capable of affording an *abundant supply* of these elements to *many generations of plants;* and, notwithstanding this, there are soils containing a much larger quantity of these substances, which, if not absolutely barren, are only capable of supporting a very scanty vegetation.

"These facts have rendered it obvious that it is not merely the presence, but the accessibility, so to speak, of the constituents of a soil that must be determined; and when the chemist, in addition to the exact proportion of these minute quantities, is required to ascertain the various forms of combination in which they exist, it is natural that he should show little disposition to enter upon a branch of investigation of such complexity, and which, in the present state of our knowledge, is likely to give only negative results.

"The difficulties of this investigation have been so fully recognized by Liebig that he has pronounced it impossible to arrive at a satisfactory knowledge of the composition of the soil and its suitableness for particular crops by analysis alone."

ACTION OF THE SOIL ON VEGETATION.

The late Professor Gregory left the following summary of recent views relative to the action of soil on vegetation:

1. Way, and after him Liebig, have shown that every soil absorbs ammonia, and also potash, from solutions containing them or their salts, generally leaving the acid, which takes up lime, &c., from the soil in solution. The ammonia and potash which are absorbed in very large proportion by arable soils are rendered thereby quite insoluble.

2. Arable soils absorb also silicic acid in very considerable proportion, and it also becomes insoluble.

3. Arable soils also absorb the phosphoric acid of phosphate of lime, or of ammoniaco-magnesian phosphate, apparently soluting the acid, which also becomes insoluble.

4. Hence the soluble ingredients of manures cannot be conveyed to the plants in the form of a solution percolating the soil, (such as liquid manure, or a solution formed by rain-water with the aid of carbonic acid,) since such a solution is deprived of its dissolved ingredients by filtering through a very moderate amount of soil.

5. Hence, also, as the food of plants must thus be fixed in the soil in an insoluble form, it is plain that it can only enter the plant in virtue of some power or agency in the roots which decompose the insoluble compounds in the soil, and thus renders soluble the necessary matter.

6. The absorbent power of soils is partly chemical and partly mechanical, as is the case with charcoal.

7. The quantities of alkalies, of phosphates of ammonia, &c., capable of being supplied to plants by rain-water, after it has been percolated through the soil, even supposing the whole to be assimilated, does not amount to more than a mere fraction of what the plants contain.

8. The theory of the transference of ammonia, potash, silica, phosphates, &c., from the soil to the plant, is not yet understood; but the old theory that the rain conveys food to the plant directly is certainly not the true one.—*Edin. New Phil. Journal.*

SUBSOIL PLOUGHING.

The following striking testimony of the value of subsoil ploughing is given by Sir Edmund Stracey, an English gentleman farmer, in a recent agricultural journal.

On coming, he remarks, to reside on my estate at Blackheath, about six years since, I found five hundred acres of heath land, composing two farms, [which had been inclosed under an act of Parliment about forty years,] without tenants; the gorse, heather and fern shooting up in all parts. In short, the land was in such a condition that the crops returned not the seed sown. The soil was a loose, loamy soil, and had been broken up by the plough to a depth not exceeding *four inches*, beneath which was a substratum, [provincially an iron pan,] so hard that with difficulty could a pickax be made to enter in many places, and my bailiff, who had looked after the land for thirty-five years, told me that the lands were not worth cultivation; that all the neighboring farmers said the same thing, and that there was but one thing to be done, viz: to plant with fir and forest trees; but to this I paid but little attention, as I had, the year preceding, allotted some parcels of ground, taken out of the adjoining lands, to some cottagers, to each cottage about one third of an acre. The crops on all these allotments looked fine, healthy and good, producing excellent wheat, carrots, peas, cabbage, potatoes and other vegetables in abundance. The question then was, how was this done? On the outside of the cottage allotments all was barren. It could not be by the manure that had been laid on, for the cottagers had none but that which they had scraped from the roads. The magic I could ascribe to nothing else than the spade; they had broken up the land eighteen inches deep. As to digging up five hundred acres with the spade, to the depth of eighteen inches, at an expense of six pounds an acre, I would not attempt it. I accordingly considered that a plough might be so constructed as to loosen the soil to the depth of eighteen inches, keeping the best soil to the depth of four inches, and near the surface, thus admitting air and moisture to the roots of the plants and enabling them to extend their spongioles in search of food, for air, moisture and extent of pasture are as necessary to the thriving and increase of vegetables as of animals. In this attempt I succeeded, as the result will show. I have now broken up all these five hundred acres, eighteen inches deep. The process was by sending a common plough, drawn by two horses, to precede, which turned over the ground to the depth of four inches; my subsoil plough immediately followed in the furrow made, drawn by four horses, stirring and breaking the soil twelve or fourteen inches deeper, but not turning it over. Sometimes the iron pan was so hard that the horses were set fast, and it became necessary to use the pickax to release them before they could proceed. After the first year, the land produces double the former crops, many of the carrots being sixteen inches in length and of proportionate thickness. This amendment could have arisen solely from the deep ploughing. Manure I had scarcely any, the land not producing clover sufficient to keep any stock worth mentioning, and it was not possible to procure sufficient quantity from the town. The plough tore up by the

roots all the old gorse, heather and fern, so that the land lost all the distinctive character of heath land the first year after the deep ploughing, which it had retained, notwithstanding the ploughing with the common ploughs, for thirty-five years. After this subsoil ploughing, the crop of wheat was strong and long in the straw, and the grain close bosomed and heavy, weighing fully sixty-four pounds to the bushel. The quantity, as might be expected, not large, (about twenty-six bushels to the acre,) but great in comparison to what it produced before. The millers were desirous of purchasing it, and could scarcely believe it was grown on the heath land, as in former years my bailiff could with difficulty get a miller to look at his sample. Let this be borne in mind that this land then had no manure for years, was run out, and could only have been ameliorated by the admission of air and moisture by the deep ploughing.

DIRECTIONS TO BE TAKEN IN PLOUGHING.

The direction to be taken in ploughing cannot always be determined beforehand; it depends on the form and surface of the land. If the soil is impervious, and the furrows intended for drainage-lines, it will be advisable to plough in the most inclined direction, in order that the water may be easily drained. However, if the land be much inclined, it will be better to plough in an oblique direction, to diminish the slope and the current of water, and thus prevent any injury. In lands which are so inclined that the animals cannot work in the most inclined direction, an oblique direction is decidedly the best. It is the only method which gives the land a regular inclination, and the same on both sides of the furrow. In following an oblique direction, on the contrary, the earth is sometimes turned up and sometimes down, in an irregular manner quite upside down. This direction, although bad, is unavoidable; in lands so much inclined, perfection of labor must be sacrificed to the possibility of its being performed. In ploughing lands of this description the animals have two difficulties to contend with, arising from the nature of the soil. These are—the slope they must climb and the turning up of the soil from below.

In permeable lands having little or no inclination, the geometrical form of the field must determine the direction in which they should plough.—*Journal d' Agriculture Pratique*, 1859.

SUBSOILING FOR BOTTOM.

The success of the cotton plant depends materially upon the ability of the tap-root to sink deeply into the soil; for although it has other roots, still if the tap-root be not fairly established and of full size and figure, the cotton plant cannot thrive, particularly during seasons of drouth. No untried experiment promises so well as the use of the lifting subsoil plough to its greatest depth immediately under the centre, and before the forming of the cotton bed. This plough may be passed deeply in the subsoil, disintegrating all above it as finely as a mole track and without elevating the subsoil; therefore, when its character is of a kind not authorizing its elevation, it may be disturbed and pulverized in place, without being mixed with the upper soil. Then the ridging and back-furrowing system, which forms the cotton bed with the usual manner of elevated culture, does not furnish simply a mass of soil above the surface of the water furrow for the tap-root to stand in, subject to severe heat and drouth, but it permits its descent into a well disintegrated soil, which, from its depth and consequent lower temperature, will be able continuously to condense moisture from the atmosphere circulating between its particles, and the capillary attraction of the soil will elevate this moisture at least within the region of the tap-root, if not to many of the side roots. If any cotton planter doubt this fact, let him take the earth out of an old post-hole, and at any depth he likes he will discover it to contain more moisture than the same quantity of the adjoining soil which has never been disintegrated. It must be remembered that when a tap-root, whatever be its length, rests in a moist soil, the functions of the plant will continually assist in the elevation of the moisture; the leaves may be viewed as the termini of millions of infinitesimal tubes, and the air blowing past them renders each capable, on the principle of the Hungarian pump, to elevate moisture. Every waving of the plant or tree tends to produce this result. The lower end of a rattan placed in a basin of water and the upper end continually vibrated in the atmosphere will exemplify this truth; for the water will rise through the capillary tubes of this rattan, and will be thrown off at its upper end. Can it be doubted, then, that if atmosphere circulate in well disintegrated soil, and that soil is at a temperature lower than that of the atmosphere, that the condensation will continually occur? The very fact that a cold pitcher placed in a sunbeam will be covered with drops of water on the outside, which are evidently condensed from the atmosphere, proves this effect. During drouth, moisture is not put out of existence; if it does not exist in the soil, it must exist in the atmosphere; and if the depth of disintegration of the soil be sufficient, it is rendered capable of receiving any moisture that the atmosphere may happen to contain.

We would further call the attention of our friends at the South to the fact that all the water condensed during times when rains do not occur has a value far greater than the same measure of rain water. This may be thus understood: the first pint of water which runs from the roof at the beginning of rain will be found to contain large amounts of all those matters which the surface of nature has been exuding into the atmosphere. Dews and rains cleanse the atmosphere, and in the early part of their fall they become distinctly foul in their odor. During drouth, then, condensations on colder surfaces are always fully charged with these gases; even phosphoric and sulphuric acids are detectible in moisture so collected. Fill a large glass tube with pounded ice, put a cork in its lower end, then stand it in an upright position in a bowl or tumbler and expose it to a noonday sun. The condensation on the outside of that tube, from the atmosphere, will be sufficiently rapid to run down into the tumbler, and this water will prove to be foul, and relatively, as a manurial agent, of much greater value than the average quality of rain water.

We would not confine the use of the subsoil plough to the preparation of the cotton bed, but during the growth of the cotton we would pass it deeply through the centre of the water furrow, thus preparing the land for the next year's operations, when the cotton row will occupy that space; for it is to this alternation of locality of the cotton row that the planter is indebted for the fact that his lands have not deteriorated as rapidly as have the majority of those on the Atlantic slope which have been appropriated to the broadcast crops.

This principle has been illustrated by the experiments of the Rev. Mr. Smith, of Lois Weedon, England, in the growing of wheat. He sows three rows of wheat at ten inches apart, then leaves a space of thirty inches, and sows three rows of wheat again, and so over the whole acre; thus it will be seen that but half his acre is occupied by wheat, and half of these thirty inch spaces between. He commenced his experiment fourteen years ago, and then, by passing the horse hoe freely through the thirty inch space during the growth of the wheat, succeeded in raising twenty-six bushels to the acre, or rather to the half-acre, as but half the space contained wheat. His neighbors, who sowed broadcast, required an entire acre to raise the twenty-six bushels. The following year Mr. Smith did not require to let his land lie fallow or go to another crop, but he planted his wheat on the intervals, leaving the portion occupied by wheat the previous year as open spaces, as before; and thus, without the application of a manure at all, he has gone on for fourteen years, his wheat improving every year, until now he has thirty-four bushels to the acre, or rather to the half-acre, and without any succession or change in the crop.

The question naturally arises, what has caused his success? We claim that, like the water furrows in a cotton plantation, these alternate spaces of thirty inches each are storing up pabulum by the progression or change in condition of their inorganic constituents, assisted by the life principle of the wheat growing on each side of them, and thus prepare so much of their constituents as enable them to bear a wheat crop the following season. If this be true of the operations of Mr. Smith, of Lois Weedon, as no practical man can doubt, then it is true in degree of the alternating system by which cotton has been grown; and this matter of degree may be materially increased by the proper disturbance of the water furrows during the growth of the cotton.

We claim that the disturbance of this intervening space between the cotton rows by the lifting subsoil plough, and by a properly constructed horse-shoe, will be paid for by the adjacent crop, while the improvement of the quality of the soil by the progression of the primaries it contains, will be so great as to insure an increased crop the following season. Mr. Smith has continued his experiment without manure, but at the same time freely admits that manures might have been used in his intervals with profit.

We wish the experiment could be fairly tried in the flat cultivation of cotton on soils thoroughly disturbed by the lifting subsoil plough. It will be a blessed day for the South when under-draining shall be there added to the subsoil ploughing, for this will not only materially increase the amount of crop, and relatively lessen the amount of labor, but it will also render many districts healthy which now cannot be considered so.—*Working Farmer.*

SUBSTANCES EXTRACTED FROM ARABLE LAND BY RAIN WATER.

Dr. Fraas, of Munich, has for some time been making experiments to ascertain the nature and quantity of the constituents of soils that are removed by rain water within a given time. The instrument used by him for this purpose is called a *lysimeter*, and the substances obtained have been analyzed by Herr Zoeller. They were separated from rain water that penetrated a square foot of earth, six inches deep, during the summer of 1857, from April to October. Five different extracts were analyzed:

No. 1. From cultivated and manured calcareous soil.
No. 2. From cultivated and unmanured clay soil.
No. 3. From uncultivated and unmanured clay soil

No. 4. From uncultivated and manured clay soil.

No. 5. From cultivated and manured clay soil.

The manure applied to Nos. 1, 4, and 5 consisted, in each instance, of one pound of cattle manure, without straw.

The residues left by evaporation were yellowish or blackish-brown, and very hydroscopic, (*i. e.* having the property of readily imbibing moisture.) They all contained the same constituents, with the exception of manganese, which could be detected only in Nos. 3 and 4. The bases were potash, soda, lime, magnesia, and peroxyd of iron; the acids, carbonic, silicic, nitric, sulphuric, phosphoric, and chlorine. Besides these substances there were also organic compounds, with clay and sand.

In none of these residues could the presence of a soluble compound of alumina or ammonia be recognized. It was only by boiling for a long time with concentrated caustic potash that an ammoniacal reaction became perceptible, and that was, probably, due to the decomposition of a nitrogenous organic substance. There is, however, so large an amount of nitric acid present that, when the residues of evaporation are heated upon platinum foil, they deflagrate; and when the solution is heated with sulphuric acid it decolorizes indigo solution.

This nitric acid has most likely originated chiefly from ammonia by oxydation; for, although nitric acid may be produced directly by the combination of atmospheric nitrogen with the oxygen condensed by the soil, ammonia would always be oxydized first, and converted into nitrate of ammonia.

However, since the nitric acid in the solution from soils exists in the state of a lime or magnesia salt, this is a further proof of the powerful attraction of the soil for ammonia. So that while, on the one hand, the capability of the soils to condense ordinary oxygen and oxyonize it may cause the production of nitrate of ammonia, its powerful attraction for ammonia causes the decomposition of the nitrate of ammonia, the base being retained by the soil, while the nitric acid combines with lime or magnesia.

The analyses show that one million parts of the water passing through soil six inches deep contained—

Solid residue, dried at 212°	472.32	254.62	292.64	305.20	291.50
Fixed portion	317.62	176.74	194.75	214.50	212.16
Potash	6.50	2.37	2.03	5.46	3.82
Soda	7.11	5.60	7.43	23.74	6.02
Lime	145.86	57.60	70.80	68.41	92.34
Magnesia	20.52	8.88	1.32	2.93	5.12
Peroxyd of iron	1.32	6.35	8.26	5.76	4.30
Chlorine	57.49	9.52	20.87	39.46	35.27
Phosphoric acid	2.23	----	----	----	----
Sulphuric acid	17.47	27.13	27.82	29.30	33.49
Silica, (soluble)	10.46	11.35	17.46	9.50	9.34

These analyses illustrated the absorptive power of soils, first pointed out by Mr. Way as so important in its influence upon the nutrition of plants. With one exception only, neither phosphoric acid nor ammonia were present in sensible amount. The quantity of potash is, in all instances, small, and principally referable to the organic substance in the solution. Chlorine, sulphuric acid, and nitric acid salts are not retained by the soil.

If these analyses show the substances that are dissolved from the soil, the opinion that plants derive their nutriment from solutions must be given up. The soils experimented upon gave good crops of corn and straw, and the quantities of potash and phosphoric acid required by these crops much exceed those which would be furnished by solutions of the above composition. Moreover, the comparison of the ash of cereals and the substance dissolved from the soil is inconsistent with the opinion that the food of plants is supplied in solution, unless they are supposed to possess a very considerable selective power. —*Annalen der Chemie und Pharmacie.*

ON THE USE OF DRIED SURFACE EARTH AS A DISINFECTANT FOR HUMAN FECES AND AS A MANURE.

The power and efficacy of this agent will, however, be best understood and believed if I give a simple narrative of what, during the last six months, it has done for my own family, averaging during that period fifteen persons daily. Eight months previous to this period, under a strong impression of the evils either occasioned or likely to be occasioned, by the vault or cess-pool on my premises, and feeling it to be a nuisance to my next neighbor as well as to myself, I filled it up with earth, and ever since I have had everything that would

otherwise gone into it received and removed in buckets. And even this mode of removal, though offensive in idea, has proved far less so, in reality, than even a very small portion of the evils it is intended to remedy. At first, the contents of these buckets were buried in trenches about a foot deep in my garden; but on the accidental discovery that in three or four weeks after being thus deposited not a trace of this matter could be discovered, I had a shed erected, the earth beneath it sifted, and with a portion of this the contents of the buckets every morning mixed, as a man would roughly mix mortar. The whole operation of removing and mixing does not occupy a boy more than a quarter of an hour; and within ten minutes after its completion neither the eye nor nose can perceive anything offensive. This was the first observation I made. The next was this, that when all the earth, which did not exceed three cart-loads, had been thus employed, that which had been first used was sufficiently dried to be used for the same purpose again; and it absorbed and deodorized the offensive matter as readily as at the first time. And so singularly does this capability continue, that a portion of it is now being used for the *fifth* time for the same purpose; and thus all that offensive matter which otherwise would have been wasted in the vault, a nuisance to my house and the neighborhood, and a source, it may be, of sickness and disease, is now a mass of valuable manure, perfectly inoffensive to the eye and nose. I have taken fifty or sixty persons to see it without previously acquainting them with its nature, and not one has guessed it. All have declared it to be wholly without offence. Two have handled and smelt that in the afternoon which had been mixed in the morning, without being able to discover its nature. And more than this, I have the same day submitted some to strong fire-heat; and that which, unmixed with earth, would, under such heat, have been intolerable, in this mixed state emitted no offensive smell whatever. Again: a supply of manure for the garden is thus readily provided. A farmer and several laborers to whom I mentioned the following simple plan at once entered into it: The present vault is to be discontinued, and in the place of it there is to be under the seat a small enclosure of brick or stone, six or nine inches deep. To preserve the full value of the manure for the garden, this enclosure should be paved, or have a flat stone for its bottom. It would, of course, be closed with a door. On one side would be a small rough shed, capable of covering and keeping dry a cart-load of earth for the purpose of mixing, and on the other side a similar shed, into which the soil so mixed would day by day be thrown, for the purpose of drying. When dry, this would be used again, and the uses of the two sheds be reversed. By thus repeatedly using it, and sifting it backwards and forwards from one shed to the other, one load of earth will be found sufficient for five persons certainly for six months, and, I believe, for twelve. This is the simplest, but by no means the least offensive mode of applying this remarkable agent.—*National Health and Wealth, by Rev. H. Moule, England.*

ON THE ESSENTIAL MANURING CONSTITUENTS OF CERTAIN CROPS.

At the Aberdeen meeting of the British Association, Professor Voelcker detailed the results of certain field experiments, having special reference to the turnip crop, which had extended over a period of four years. These are the most important points cited:

1. That fertilizers destitute of phosphoric acid do not increase the yield of this crop.
2. That phosphate of lime applied to the soil in the shape of soluble phosphate (super-phosphate) increases this crop in an especial manner, and that the practical value of artificial manures for root-crops chiefly depends on the relative amount of available phosphates which they contain. Thus it was shown that three hundred weight of super-phosphate per acre produced as large an increase of turnips as fifteen tons of farm-yard manure.
3. That ammoniacal salts and nitrogenized constituents, yielding ammonia on decomposition, have no beneficial effects upon turnips, but rather the reverse.
4. That ammoniacal salts applied alone do not promote, as maintained erroneously, the luxuriant development of leaves; but that they produce this effect to a certain extent where salts of ammonia are applied to the land in conjunction with the mineral constituents found in the ashes of turnips.

The report likewise states that numerous analyses of turnips have been made, from which it appears that the more nutritious and least ripened roots invariably contain less nitrogen than half-ripened roots or turnips of low feeding qualities. In the latter the proportion of nitrogen was found in several instances two to two and a half times as high as in roots distinguished for their good feeding qualities.

Similar experiments upon wheat showed that nitrogenized ammoniacal matters, which proved inefficacious in relation to turnips, increase the yield in corn and straw very materially, and that the increase of wheat was largest when the ammoniacal constituents were associated with mineral matters.

LIQUID MANURE.

The following are the conclusions arrived at by Dr. Voelcker, of England, on the subject of liquid manure, as deduced from a series of experiments detailed in a paper "On the changes which *liquid manure* undergoes in contact with soils of known composition," published in the twentieth volume, page 134, of the Journal of the *Royal Agricultural Society of England:*

1. Liquid manure, in contact with soil, undergoes a number of chemical changes.
2. These changes are greater in the case of clay and calcareous soils than in the case of sandy soils.
3. Passed through clay, loamy, and calcareous soils, liquid manure leaves a considerable quantity of ammonia in the soil.
4. Under the same circumstances, liquid manure parts likewise with potash and phosphoric acid.
5. Sandy soils remove from liquid manure but little ammonia, and likewise not much potash.
6. With the exception of purely sandy soils, liquid manure, as used in practice, leaves the greater portion of all the most valuable fertilizing matters in the generality of soils.
7. The comparative power of different soils to remove ammonia, potash, and phosphoric acid from liquid manure, differs greatly.
8. Liquid manure passed through sandy soils rich in soluble silica takes up soluble silica.
9. Soils that absorbed much ammonia also absorbed much potash, and the soils which absorbed little ammonia also absorbed little potash.
10. Soda salts (common salt) are either not at all removed by liquid manure, or only to a small extent.
11. Chlorine, and generally sulphuric acid, remain unaltered in quantity in liquid manure passed through different soils.
12. In most cases liquid manure left in contact with different soils becomes richer in lime.
13. The proportion of lime which liquid manure takes up from the soils with which it is brought in contact does not altogether correspond with the relative proportions of lime in the different soils.
14. Liquid manure passed through a sandy soil greatly deficient in lime became poorer in lime; thus showing that the property of soils, of storing up food for plants, is not confined to ammonia, potash, or phosphoric acid, but that it is a property which manifests itself in a variety of ways. Thus soils rich in lime yield this substance to liquid manure. Again, potash usually is removed from liquid manure left in contact with soils; but in particular cases liquid manure may even become richer in potash after filtration through soil.
15. Very soluble saline fertilizing compounds are probably injurious to vegetation when supplied too abundantly to the land.
16. All moderately fertile soils have the power of rendering the more important soluble fertilizing matters much less soluble; but in none of the experiments were ammonia, potash, phosphoric acid and other compounds that enter into the composition of the ashes of our cultivated crops, rendered perfectly insoluble.
17. It does not appear probable that plants take up mineral food from the soil in the shape of totally insoluble combinations.

FARM-YARD MANURE.—DR. VOELCKER'S EXPERIMENTS.

The composition of farm-yard manure, in regard to which our knowledge has, up to the present time, been far from satisfactory, has received a very important elucidation from the laborious investigations of Voelcker. His experiments were made upon considerable quantities of manure, treated in different manners, for the purpose of observing the changes it undergoes; and great care appears to have been exercised in all the operations, and particularly in selecting samples for analysis. It appears that the great loss to which farm-yard manure is subject is not evaporation of ammonia into the air—for this really takes place to a very small extent—but chiefly to the rain washing out the soluble matters.

The following table, giving the composition in pounds of an experimental heap of manure at four different periods, will give some idea of the changes which occur :

	Nov. 3, 1854.	April 30, 1855.	August 23.	Nov. 15.
Weight of manure in lbs.	2,838	2,026	1,994	1,974
Water	1877.9	1336.1	1505.3	1466.5
Dry matter	960.1	689.9	488.7	507.5
Soluble organic matters	70.38	86.51	58.83	54.04
Soluble inorganic matters	43.71	57.88	39.16	36.89
Insoluble organic matters	731.07	389.74	243.22	214.92
Insoluble inorganic matters	114.94	155.77	147.49	201.65
	960.1	689.9	488.7	507.5
Total nitrogen	18.23	18.14	13.14	13.03
Equal to ammonia	22.14	22.02	15.96	15.75

It is to be observed that during the first six months, although the weight of the manure largely diminished, the loss was almost exclusively confined to the insoluble organic matters; while soluble matters had increased, and the ammonia remained undiminished. But during the hot summer weather all the most valuable matters had undergone diminution.

Many important and elaborate analyses are contained in Dr. Voelcker's paper which show the composition of the dung when treated under different systems. The conclusions to which they lead are these: Farm yard manure, in its fresh state, contains but a small quantity of ammonia, most of its nitrogen being there as insoluble nitrogenous matters. But as the decomposition advances the ammonia increases, and a quantity of organic matter becomes soluble. For this reason the manure should be preserved in such a manner as to prevent the escape of the soluble portions which are the most valuable. This can be effected by keeping it in water-tight pits, or under cover; but in the latter case the manure, particularly if it contain a large proportion of litter, is not sufficiently moist to admit of its ready fermentation, and water must be added in sufficient quantity to promote that change. The worst of all modes of keeping manure is to pile it in heaps in the corners of the fields, for under such circumstances it is most liable to loss; and if the manure must be carted out, it is better to spread it upon the soil at once, because when this is done fermentation is stopped; and as there is very little free ammonia the loss is small, and the soluble matters are uniformly washed into the soil by the rain. Dr. Voelcker is of opinion that the most advantageous mode of applying the manure would be in all cases to leave it on the surface to be washed into the soil, by which means its distribution is more uniform than if it be ploughed in. The most disadvantageous mode of making manure is to produce it by cattle in open yards, for in this way at least two-thirds of the valuable matters are lost after a year's exposure.—*From a paper, "Recent Progress of Scientific Agriculture," by Dr. Anderson, in October* (1858,) *Number of "Transactions of Highland Society."*

FARM-YARD MANURE.—DR. CAMERON.

The following is an abstract of a paper on the above subject, presented at a late meeting of the Dublin Chemical Society by Dr. Cameron :

"1st. Farm-yard manure, when applied in sufficient quantity, is the best manure which can be employed alone, inasmuch as it contains all the elements required to nourish every kind of cultivated plant.

"2d. A mixture of farm-yard manure and super-phosphate of lime or guano formed the best fertilizer that could be employed for every kind of crop, but more especially turnips and root-crops generally. The farm-yard manure supplies all the elements of the food of plants, and by its decay in the soil causes the latter to have a higher temperature than it would have if manured with guano or super-phosphate of lime alone. The artificial manure was a valuable auxiliary to the natural; it contributed one, and sometimes two and three ingredients of the food of plants; but it was especially useful as a means of forcing the young plants out of the reach of the fly.

"3d. Whilst Peruvian guano, in combination with super-phosphate of lime or farm-yard manure, was a most valuable adjunct, yet its continued use *per se* would be attended with injurious results, and for the following reason :—Peruvian guano contained a very large pro-

portion of ammoniacal matter in relation to the amount of phosphate of lime found in it. This ammoniacal matter acted as a solvent upon certain constituents of the soil, and rendered them available for the purpose of vegetable nutrition much sooner than would be the case if no guano were applied. Thus the guano not only contributed itself to the food of plants, but enabled the plants to draw (so to speak) in advance upon the resources of the soil, which, if they did not exist in great abundance, would speedily be exhausted under the stimulating influence of the guano.

"4th. Phosphate manures, such as super-phosphate of lime, and even such as phospho-Peruvian guano, which contained a moderate proportion of nitrogenous matters, exerted but little solvent action upon the fertilizing constituents of the soil. The effects therefore which such manures were observed to produce in the development of plants might be attributed solely to the nutriment afforded by these manures, and not to the intervention between the plant and the soil."

He recommended a mixture of two parts of super-phosphate of lime and one of Peruvian guano, in preference to the use of guano alone; and this mixture might with advantage be employed for every variety of crop.

ON THE VALUE AND USE OF URINE AS A FERTILIZER.

If we calculate the quantity for a single individual at 500 pounds per annum, this would give for 1,000 inhabitants 223 tons, which, according to Professor Johnson's valuation at £10 a ton, would amount to £2,230, (about $11,000.) But human urine is more valuable than guano, as will be evident by a reference to the following table of Professors Hembstadt and Schubler:

Table showing the result of experiments with different manures.

	Quantity in proportion to seed.
No manure	3 times.
Herbage, grass, leaves, &c.	5 "
Cow-dung	7 "
Pigeon's-dung	9 "
Horse-dung	10 "
Human urine	12 "
Sheep's-dung	12 "
Human manure or bullock's blood	14 "

It also gives the largest proportion of gluten when applied to wheat crops, as shown by the next table:

	Gluten.	Starch.	Bran, &c.
Human urine	35.1	39.3	25.6
Bullocks' blood	34.2	41.3	25.5
Night soil	33.1	41.4	25.5
Horse-dung	13.7	61.6	24.7

A pound of wheat, therefore, raised from land manured with urine would be nearly three times more nourishing than that produced on land manured with horse-dung—a circumstance of some importance in a social and economical point of view.—*Parkins on the "Causation and Prevention of Disease."*

QUANTITY OF MANURE ANNUALLY PRODUCED BY DIFFERENT KINDS OF FOWLS.

A farmer who raises a number of fowls has given the following table of the manure produced by the different kinds:

	In a night.	Year.
Pigeon	gr. 7¼	kilgr. 2.762
Chicken	" 15	" 5.523
Duck	" 22½	" 8.285
Goose	" 30¼	" 11.047
Turkey	" 30¼	" 11.047

From "Journal (June, 1859) de la Société Centrale d'Agriculture de Belgique."

THE MANURIAL VALUE OF STRAW.

The common estimate of the manurial value of straw is that one ton of straw converted into manure will produce three tons of dung. Taking the value of the dung at 5*s*. per ton, this gives a value of 15*s*. per ton as the manurial value of one ton of straw. Owing to the short cereal and leguminous crop in Scotland, straw is scarce, and when sold it is realizing from three to four times its manurial value. It is therefore clearly the interest of farmers so to economize straw as to have a portion to sell, rather than to tramp it down with cattle, and otherwise dispose of it for converting it into manure. The money obtained by the sale of straw expended on manures will give a much larger return; strawy manure—that is, manure made principally from straw—containing little fertilizing matter beyond silica and carbon, the latter not a necessary constituent of a fertilizer. For economizing straw in bedding stock other substances can be used with advantage—sawdust, ferns, and other vegetable matter.—*North British Agriculturist.*

SALT.

Salt may be used profitably in a crude state, sown broadcast over the fields, particularly old mowing or pasture lots, where the grass is "running out." The quantity recommended in England, and also by those who have used it in this country, ranges from three to twenty bushels per acre.

As a preventive remedy for worms, our opinion is that there is nothing to be compared with salt. For this purpose it must be used liberally, that is, at the rate of ten or fifteen bushels per acre.

Salt is one of the best things that can be used upon garden walks, either gravelled or paved, to prevent weeds from growing. For this purpose enough must be put on to kill vegetation. Weeds in an asparagus bed may be salted to death, and the asparagus benefited.—*New York Tribune.*

HOW TO KNOW GOOD GUANO.

Although this question has been already examined in many of our journals, yet we think it will not be out of place to make the following observations, in order to give farmers the means of protecting themselves from adulteration of all kinds, of which guano has become the subject.

First, *Color of Guano.*—The color of coffee with milk is ordinarily that of good guano. If the color is too gray, it is because the guano is earthy. When it is browner, there is a considerable quantity of water in it.

Second, *Taste.*—The stronger the flavor of the guanos, as salt, piquant, and caustic, the richer they are in ammoniacal salts.

Third, *Smell.*—The smell of guano can scarcely serve as a means of comparison, for it varies with the degree of dryness or moisture. However, a smell of ammonia is a good sign.

Fourth, *Consistence.*—Good guano is ordinarily oily to the touch. It is in small grains, but sometimes in large pieces. If the guano be rich in azotes, the pieces, when broken, appear shining and crystallized. When the guano is of inferior quality, it is full of earth; it is bad if it contain many stones or gravel.

Fifth, *Flame.*—A small piece of good guano put on a thin blade of platina, and held over the flame of a spirit lamp, will blaze up, burn with a long flame, and leave a residue of charcoal ashes. Guanos poor in organic matter give out less charcoal.

Sixth, *Testing it with quicklime.*—A piece of guano rubbed with a piece of quicklime emits a strong smell of ammonia.—*From "Journal de la Société Centrale d'Agriculture de Belgique," January*, 1859.

ON THE NEW GUANOS OF THE PACIFIC.

The American companies engaged in importing guano from the recently discovered "Baker" and "Jarvis" islands of the Pacific publish the following letter from Liebig descriptive of the composition and character of the new fertilizers. He says:

"I have spent two months' labor in the matter. The Baker's Island guano contains more phosphoric acid than any other known fertilizer, and it is similar in its ingredients to natural phosphorite, differing from it, however, in the following remarkable particulars:

"Phosphorite is in a crystallized state, and is completely insoluble in water. The Baker's Island guano, on the contrary, is amorphous, is soluble to a considerable extent in pure

water, and, when moistened, colors litmus paper red. The Jarvis's Island guano has also an acid reaction, and is partly soluble in water. It is worthy of remark that the Jarvis guano, although only half as rich in earthy phosphates as the Baker's, gives to water a greater quantity of soluble phosphoric acid. I regard the discovery of these guano deposits as a most fortunate event for agriculture. At the present time the prices of fertilizers, like bones, are now continually on the increase, and soon the agriculturist will not be able to procure, at paying rates, an amount sufficient for his wants. Baker's Island guano, being of all fertilizers the richest in phosphoric acid, will be of especial importance. As far as chemistry can judge, there is hardly room for a doubt that in all cases where the fertility of a field would be increased by the use of bone dust, the Baker's Island guano will be used with decided advantage. The phosphate of lime in the Baker's Island guano is far more easily dissolved than that of bones; and if we take the proportion of that ingredient to be 60 lbs. in the latter, 100 lbs. in the Baker's Island guano are equivalent to 140 lbs. of bones. Thus the agriculturist would be benefited as much by using 70 lbs. of Baker's Island guano as by 100 lbs. of bone dust. This guano contains in ammonia, nitric acid, and azotic substances, nearly one per cent. of active nitrogen. A small addition of salt of ammonia would give it the full strength of Peruvian guano.

"For turnips, clover, &c., the Jarvis Island guano is just as good as the Baker's. Judging simply from its percentage of phosphates, it is of less value as an article of importation; but it is rich in sulphate of lime, which is also a fertilizer; and its phosphoric acidis of higher value, as nearly half of it exists in soluble phosphate of lime. The Jarvis Island guano would seem to be an excellent means of restoring cotton or sugar plantations whose soil has been worn out by long-continued cultivation."

GYPSUM AND GUANO.

Within a few years past there has been some discussion in the agricultural papers in reference to the policy of mixing gypsum with guano and other nitrogenous manures, some contending that the gypsum would expel a portion of the ammonia, others as strongly denying it. Perfectly pure gypsum mixed with guano, we think, would not have a very prejudicial effect. But there are different varieties of gypsum : some are pure; others containing a large percentage of carbonate of lime ; such might expel from guano a portion of its carbonate of ammonia. Where gypsum of a good quality can be obtained at a reasonable price, we think it may be profitably used in stables and hovels, by strewing it over the floors and daily mixing it with the manure and urine of the stock. From the great amount of urine voided by the cattle, much of the gypsum would be dissolved; it is then in a condition to combine with the ammonia. For the speedy union of a salt and an acid, one of them should be in solution.

Sulphuric acid, gypsum, and copperas have all been recommended for fixing the ammonia in urine tanks. Sulphuric acid is worth about three cents per pound; gypsum, at ten dollars per ton, would bring the cost of its sulphuric acid at a trifle over one cent a pound, while the *acid* in copperas, at two cents a pound, would cost over six cents a pound. Then, of course, gypsum is the cheapest source from whence the farmer can obtain sulphuric acid for saving the ammonia in his liquid-manure tank. Put fresh urine and gypsum into a cask; in course of a few days there will be on the surface of the urine a thin, ice-like pellicle; this, when taken off and tested by an acid, will be found to be carbonate of lime, showing plainly that some of the gypsum has been decomposed ; the quicklime, in its eagerness for carbonic acid, rises to the surface, and, when it has obtained a certain thickness, it breaks and falls to the bottom, and doubtless the acid that was separated from the lime combines with the ammonia, forming an impure sulphate of ammonia. Something like this takes place in the manure heap where plaster has been used in the hovel.—*New York Country Gentleman.*

ON THE PREPARATION OF HORN FOR MANURE.

Experience shows that rasped horn is decomposed in the ground without previous manipulation, especially in garden culture. Any chemical reaction on the substance of horn always destroys at least a portion of its nitrogenous constituents. However, to produce its full action it is necessary to decompose it, which is done by means of caustic lyes, in which the horn is immersed without raising the temperature, as this would expel some of the ammonia formed. When the horn has become softened, diluted sulphuric acid is added to neutralize the alkali. Or the rasped material is kept in pits filled with thick milk of lime, then taken out and treated as before. The vessels used for the neutralization should be made of planks, lined inside with sheet-lead (six pounds to the square foot.)

ON THE VALUE OF WOOLEN RAGS AS A MANURE.

Professor Way, chemist of the Royal Agricultural Society, England, in recently investigating the value of woolen rags as a manure, felt that it would hardly be satisfactory to content himself with the analysis of wool, since, as he observes, (Jour. Royal Ag. Soc., vol. 10, p. 617,) to reason from the composition of a raw material of any kind upon that of the manufactured article, which has passed through perhaps half a dozen processes, is often to lay one's self open to much error; and nothing short of the direct analysis of the rags themselves would enable any person to form a correct notion of their manuring value. Wool, in a state of purity, contains upwards of seventeen per cent. of nitrogen. Were woolen rags, therefore, of the same strength as the wool itself, they should produce *ultimately* a larger amount of ammonia than even Peruvian guano. It will be valuable, then, to examine the chemical compositions of some of the commonly sold refuse woolen rags. These rags are well known, and extensively employed as a manure in some parts of the country.

Owing, as the Professor remarks, to their slow decomposition in the soil, they are not well fitted for root culture—turnips and other plants of this kind requiring active and readily soluble manures to produce a rapid growth. Still this must not be taken as an undoubted fact, since, in the experiments of the late Mr. Pusey on the growth of beet root, (Ibid., vol. 6, p. 530,) when thirteen tons of farm-yard manure per acre produced twenty-seven and a half tons of clean roots, the *addition* to the dung of seven hundred-weight of rags raised the produce to thirty-six tons. This increase he attributed to the large proportion of azote or nitrogen present in the rags.

Woolen rags were formerly, as Professor Way adds, to be purchased of good quality, and unmixed with any less valuable substance; but of late years rags are bought up to be reconverted into an inferior kind of cloth. The supply being in this way in part cut off, it is frequently made good by the admixture of such linen or cotton rags as may not be worth the paper-maker's attention.

Three specimens of these refuse rags were examined by the Professor: Specimen No. 1, consisting of the seams and other useless parts of old cloth, which had apparently been cut up to be re-manufactured into cloth; No. 2, called "Premings;" and No. 3, "cuttings," appeared to be much of the same character, but totally different from the rags—they both consisted essentially of colored wool less than an eighth of an inch in length. These all contained, in their ordinary state, a certain proportion of water. In the three specimens above referred to, the

Rags contained of water	7.87 per cent.
Premings	7.00 per cent.
Cuttings	8.70 per cent.

In this state, the proportion per cent. of nitrogen which they contained, and the proportion of *ammonia* which, by the decomposition of the animal matter, will be eventually produced from them, and from a specimen of "shoddy," is given in the following little table:

	Nitrogen.	Ammonia.
Rags	10.47	12.71
Premings	9.92	12.05
Cuttings	11.84	14.31
Shoddy	4.55	5.52

It appears then, says Way, that it is quite incorrect to estimate the value of the different kinds of woolen-refuse by the known composition of the wool itself; for, to whatever cause the inferiority may be due, it is plain that they do not, on an average, contain two-thirds of the nitrogen found in the raw material.

The mineral substances found in wool-refuse are of small fertilizing value. In 100 parts of inferior wool-refuse were found—

Water	7.15
Animal matter and oil	58.52
Phosphate of lime	1.48
Oxyd of iron and alumina	2.10
Carbonate of lime	9.42
Sand, &c	21.23
Loss, &c	.10

This specimen contained about 2.5 per cent. of nitrogen.

Professor Voelcker has explained the chief reasons for the considerable difference of opinion which exists in different places with regard to the fertilizing value of woolen substances.—(Ibid., vol. 16, p. 94.) These he considers are to be best understood by a reference to their analysis and the time of their application, and the physical composition of the soil. Shoddy, for instance, often contains from twenty to twenty-five per cent. of oil; which, by excluding moisture and the atmospheric air from the interior of wool hairs which compose this refuse, prevents its decomposition, as the oil in sardines, or a cover of grease the potted meat. And thus the decomposition of the shoddy is retarded for a considerable period, so that no effect is produced if it is applied to the land when the young wheat has already made its appearance, or even if applied two or three months previously. But if the same refuse is applied to the land a considerable period before the sowing of the crop which it is intended to benefit, or if it is brought previously into a state in which it will readily ferment, (and then it may be applied at once to the young wheat,) a very marked and early good effect will be produced by its use, since ammonia is then gradually formed from the nitrogen of the shoddy. In light and porous soils this necessary preparation proceeds much more rapidly than in stiff heavy lands.

The farmer, by practice, confirms his chemical conclusions. The Kentish hop-growers, we are told by Mr. S. Rutley, in his Prize essay, (Ibid., vol. 9, p. 562,) deem woolen rags, shoddy, and refuse seal-skins to be very lasting manures, but much more valuable and early in their effect on dry than on wet soils. On the Kentish hop-grounds they apply from twelve to twenty hundred-weights per acre of woolen rags, twenty to thirty hundred-weights of shoddy, and about 160 bushels per acre of seal-skin. For corn crops on light, chalky land, or for grass, about ten or twelve hundred-weights per acre of woolen refuse were used.—*Extracted from an article on Wool, communicated by Cuthbert Johnson to the English Farmers' Magazine.*

SURFACE-MANURING.

The practice of top-dressing, or of surface-manuring, has long been the favorite method employed by all intelligent gardeners within the circle of my acquaintance. We have long ago learned that masses of rich, nitrogenous manures are not what plants require about their roots, but that manures are applied much more successfully (and less injuriously) by top-dressing, either in solid or liquid form. Nature never manures her plants with crude masses of concentrated fertilizing substances, but imparts her stimulating and mineral food in a state of the most minute division—almost infinitesimal—chiefly from the surface of the earth. No wonder so many fruit trees have been killed, so many grape vines destroyed or rendered barren by excess of wood, in consequence of the heavy manuring at the roots so universally recommended by writers on gardening and horticulture.

The great objection to surface-manuring is founded upon the probable loss of ammonia, caused by the exposure of decaying manures upon the surface of the earth. But this loss has been shown, by sound reasoning and by facts deduced from practical experience, to be much less than is commonly apprehended; while the benefits arising from surface-manuring, in other respects, more than counterbalance any possible loss of ammonia from this practice.

In the first place, when manures are exposed upon the surface of the earth, even in hot weather, decomposition no longer goes on so rapidly as when the same manures are kept in a heap, and the ammonia that is produced is gradually carried into the soil by rains. The other soluble substances, as potash, lime, the phosphates, &c., are of course not lost, because they are not volatile.

Nor are these soluble and valuable substances lost to plants by being carried into the soil before they are needed by growing plants. It has been conclusively shown by eminent scientific authorities that any good soil, containing a fair proportion of clay and carbon, is capable of taking up and retaining effectually ammonia, lime, potash, soda, &c., in a soluble form, so that little, if any, passes off in the under-drainage water of such soils. These substances, it is true, may wash from the surface, but they cannot pass through a good soil and go off in the drainage water.

By surface-manuring we mulch the ground, and render it cooler in summer and warmer in winter. More shade is an important element in culture—so important that some writers have thought shade alone to be equivalent to manure. A piece of soil heavily shaded by surface-manuring actually decomposes like a manure heap—that is, it undergoes a sort of putrefaction or chemical change, which sets free its chemical constituents, unlocks, as it were, its locked-up manurial treasures, and fits its natural elements to become the food of plants. Darkness, moisture and air are the conditions required for vegetable and mineral decomposition. These conditions are produced in the soil by surface-manuring.

Then, again, when the surface-manure decomposes, its elements are washed into the soil in a state of solution precisely fitted to meet the wants of plants, and they become them-

selves active agents in promoting further decomposition and chemical changes in the entire body of the soil.

Manure, then, I say, chiefly upon the surface. Do not waste your manures by mixing them deeply with the soil. Plant shallow. Keep roots of all trees, plants, and vines as near the surface as possible. There are weighty reasons for the position assumed in the last sentence, which I have not space now to enumerate. I say again, plant shallow. Let your soil be deep and dry, but plant near the surface as much as possible. Top-dress your grass, after mowing in July or August, under a burning summer sun ; top-dress in the fall, before and during the autumn rains ; manure the surface while snow is on the ground, while the March winds blow, and while the April rains fall. Manure your grass, instead of your corn and wheat, broadcast, at any time when you have manure and leisure, and I will guarantee that you will be abundantly satisfied with the result.

To fruit growers I would say: Do not fill your soil with manure before you plant trees, grape vines, &c. Plant in good natural soil, and manure from the surface, spring and fall, liberally and properly, and I will guarantee you success far greater than if you plant in holes and trenches filled with manures, as the custom is. Surface-manuring and mulching are the true doctrines. I am sure of it.—*Mr. Bright, Gardeners' Monthly.*

INJURIOUS EFFECTS OF POUDRETTE.

Considerable attention has recently been given in Europe to the danger of using imperfectly-prepared *poudrette*, inasmuch as a variety of diseases are reported to have been propagated or fostered by the use of vegetables grown in soils manured with it. Some authorities report "that the fecal matter of sinks cannot be converted with safety into garden manure under less than five years' careful preparation." It is so stated that many of the fruits and vegetables grown by the aid of poudrette imperfectly prepared can be distinguished by the nostrils, or by the taste, before they are cooked, and during the process of cooking.

VALUE OF GAS WASTE FOR AGRICULTURAL PURPOSES.

The following paper on the above subject has been recently published by George D. Cabot, esq., agent of the Gas Company, Lawrence, Massachusetts :

Ammonia is the great source from whence plants derive their chief supply of nitrogen. When ammonia water is judiciously applied it wonderfully increases the growth of grass, wheat, turnips, and, indeed, of most vegetables. Out of the numerous instances the following are selected in evidence of its beneficial action :

In the year 1841 Mr. Wilson, of Largs, in Scotland, communicated to the Philosophical Society of Glasgow an account of an experiment made by him. "A piece of three years' old pasture, of uniform quality, I divided into ten lots of twenty perches each. All the lots were manured, at the same time, with the articles in the following table, and the grass cut and made into hay in July. Each application cost the same."

No. of lot.	Manure.	Produce of the lot. Pounds.	Pounds of hay per acre.	Increase per acre over that untried.
1	Left untouched	420	3,360	....
2	2½ barrels of quicklime	602	4,816	1,456
3	1 ton of lime from gas-works	651	5,208	1,848
4	4½ cwt. wood charcoal powder	665	5,320	1,960
5	2 bushels bone dust	693	5,544	2,184
6	18 lbs. nitrate potash	742	5,936	2,576
7	20 lbs. nitrate soda	784	6,272	2,912
8	10 bushels soot	819	0,552	3,192
9	28 lbs. sulphate ammonia	874	6,776	3,416
10	100 gals. ammoniacal liquor from gas-works	945	7,562	4,200

A similar experiment was made, though with another purpose, by M. F. Kuhlman, a German chemist. He tried seven manures, all containing ammonia, and the result was, that the ammoniacal liquor from gas-works produced more hay than some of the manures, and less than two of them.

Mr. J. Watson says: "The ammoniacal liquor from gas-works has been found a very great improvement as a manure for the raising crops of grass, by being sprinkled on the field in the same way as water is put on public streets in large towns to keep down the dust in dry weather. I have myself seen an experiment of this tried, and can say that part of a field of grass sprinkled in this way, after first cutting, was far superior to any other part of the field receiving manure of any other kind, and that the part so sprinkled or showered over was ready to be put down a second time in the course of between fourteen days or three weeks, whereas the other part of the field, cut at the same time, was only beginning to spring or rise from the roots in that time. It had to be mixed up before use with four parts of water."

Another gentleman says: "In the beginning of April I watered half a clay land meadow of five acres with ammoniacal liquor from gas-works, diluted with five times the quantity of water. In three days I perceived that all the moss and many of the finer blades of grass close to the ground were destroyed. The bulk of the herbage, however, appeared to be unaffected; but in a week there was a decided improvement in the portion manured, and from that time there has been an increased quantity and an improved quality of grass. Its color is darker than the other. Any stock prefer grazing on that side of the meadow."

Mr. Joseph Butterworth, of Rochdale, states: "I put on a portion of my meadow three barrels of ammoniacal liquor obtained from the gas-works and mixed with an equal portion of water. The difference was seen in a short time; the grass was of a lively dark green, and was considerably higher and thicker than the other parts of the field; indeed, the difference in appearance was so great that many persons came to me to inquire as to the cause. The crop of hay was full twice as much as from that part of the field where it was not applied. Since that time I have used ammoniacal liquor on the whole of my farm."

An experiment by J. M. Tylden. "I selected two perches of similar adjoining land. It had a good crop of mangel wurzel upon it the previous autumn. No. 1 was manured with half the following compost: one gallon ammoniacal gas liquor, half a bushel saw-dust, coal ashes, and gypsum sufficient to fix the ammonia, half a pint of gas tar, one pound nitrate of soda, and four barrow loads of rubbish, turf and weeds. In about three weeks the gas liquor had decomposed this mass; half of it I dug into No. 1 a few days before planting. On No. 2 no manure of any kind was put. Both lots were planted with wheat and came up well. In a short time No. 2 was much eaten by the wire worm, whilst No. 1 was scarcely touched. No. 1 yielded one gallon two quarts, and No. 2 three quarts one pint. The compost appears to destroy the wire worm."

A question may arise as to the best method of using it, and as to the most suitable time. The most proper strength for using it would be to mix the ammoniacal liquor as it comes from the gas-works with at least five parts water. If it be laid on the land during a shower it may be used stronger, about half liquor and half water; cloudy weather is the most fitting for its application. An excellent mode of using ammoniacal liquor would be to mix it with substances that will absorb it, such as dry saw-dust, charcoal and the dry scrapings of the road, and when thus absorbed to be thrown on to the land or ploughed in. The most suitable time of the year to apply it is on grass lands after the grass has begun to grow in the spring and immediately after the first cutting of grass—if in the spring, the proportion should be one gallon of liquor to seven gallons of water; if after cutting the grass, about one part to five parts. When used for seeds or roots they should be allowed to sprout before its application, and then used in a very weak state, or else used as a compost before they are sown or set. To the gardener, especially, there is an advantage in the use of gas ammoniacal liquor, because of the property it possesses of destroying noxious insects. A convenient mode of applying the liquor in such cases would be with a large syringe. What has been said may induce some *to try the effect of the application of ammoniacal liquors on their land.*

ON THE SOURCE OF THE NITROGEN IN PLANTS.

One of the most interesting questions of the present day, pertaining to agricultural chemistry, is that of the source from whence growing plants derive their nitrogen. It has been satisfactorily proved that plants growing in the ordinary way often contain more of the element nitrogen than they can obtain from the soil in which their roots are placed; and it is obvious that in some way or other this accumulation is derived from the atmosphere. Now, the air surrounding the globe is composed of a mixture of nitrogen and oxygen gases, in the proportion of about four parts of the former to one part of the latter; it also contains small quantities of other gases, such as carbonic acid, nitric acid and ammonia. The question at issue is, as to whether plants can, under any circumstrances, make use of the great bulk of the nitrogen of the air in building up their tissues, or whether they derive the observed excess from the ammonia and nitric acid of the air. This question, the interest of which, both in a purely scientific and agricultural point of view, can hardly be overrated, has enlisted the energies of chemists on both sides, and has given rise to some admirable

researches. It has also involved the extended examination of air and rain-water, in order to ascertain how much ammonia and nitric acid are usually contained in the one and brought down by the other.

The principals in this discussion in France are MM. Boussingault and Ville; both of these chemists have made extended series of experiments on plants grown in glass cases; their conclusions are, however, diametrically opposite; M. Boussingault contending that plants cannot make use of the atmospheric nitrogen, but seems to be indebted to the nitric acid and ammonia in the air for their supply in excess over that furnished by the soil; M. Ville maintaining that in the absence of both of these an increase of nitrogen in plants still takes place.

At the meeting of the American Association for the Promotion of Science, Mr. Pugh stated that he had, under the auspices of Mr. Lawes, of Rothamsted, England, and at an expense of $6,000, devoted three years to the investigation of this subject, and the conclusion arrived at,—without going into details,—was, *that no assimilation of gaseous nitrogen takes place*—a result coinciding with that arrived at by Boussingault; the experiments had been conducted with the principal cereal plants—wheat, barley, oats, peas, beans, buckwheat, and with clover and tobacco. In regard to all but the leguminous plants there could be no doubt as to the above result. With the latter the experiments were less decisive, in consequence of their not having given results so satisfactory as in the case of the others.

ON THE EMPLOYMENT OF THE NITROGEN OF THE ATMOSPHERE FOR THE PRODUCTION OF AMMONIA FOR FERTILIZING PURPOSES.

Since the determination of the value of ammonia, ammoniacal salts and nitrogenous compounds generally as fertilizers, the artificial production of ammonia has been regarded as a problem of the highest interest to agriculture. But to arrive at this result it is necessary to obtain the nitrogen elsewhere than in the nitrogenous matters, which may, for the most part, be employed directly as manures, and of which the limited quantities and elevated price permits, in any event, only restricted and costly manufacture. "Atmospheric air is an inexhaustible and gratuitous source of nitrogen. However, this element presents so great an indifference in its chemical reactions that, notwithstanding the numerous attempts which have been made, chemists have not heretofore succeeded in combining it with hydrogen so as to produce ammonia artificially.

This result, so long desired, is reported to have been obtained during the past year by MM. Margueritte and de Sourdeval, two French chemists, who employ as their agent in the process the earthy base, baryta; converting it, by the aid of atmospheric nitrogen, into cyanide of barium. The following is the substance of the process employed, as given by the Abbé Moigno, in his journal "Cosmos," (Paris.)

In an earthen retort is calcined, at an elevated and sustained temperature, a mixture of carbonate of baryta, iron filings in the proportion of about 30 for 100, the refuse of coal tar, and saw-dust. This produces a reduction to the state of anhydrous baryta, of the greater part of the carbonate employed. Afterwards, across the porous mass, is slowly passed a current of air, the oxygen of which is converted into carbonic oxyd by its passage over a column of incandescent charcoal, while its nitrogen, in presence of the charcoal and of the barium, transforms itself into cyanogen, and produces considerable quantities of cyanide of barium. In effect, the matter sheltered from the air and cooled and washed with boiling water gives with the salts of iron an abundant precipitate of Prussian blue. The mixture thus calcined and cyanuretted is received into a cylinder of either cast or wrought iron, which serves both as an extinguisher and as an apparatus for the transformation of the cyanide. Through this cylinder, at a temperature less than 300°, (Centigrade,) is passed a current of steam which disengages, under the form of ammonia, all the nitrogen contained in the cyanide of barium.

Cosmos, from whence the above information is derived, further remarks that it is impossible to foresee all the results of this great discovery. Among other things, it suggests the production of nitric acid from the air by oxydizing ammonia.

ON THE SOURCE AND USE OF NITRATES IN AGRICULTURE.

All chemists are agreed that the principal source of nitrogen in plants is the atmosphere. Most of them are also agreed that nitrogen is *not* absorbed by plants directly, but through the intervention of the ammonia and nitric acid contained in the atmosphere, while a small minority maintain that plants absorb free nitrogen directly from the atmosphere. It has, however, been a disputed point as to whether plants assimilate all their nitrogen directly from ammonia, the nitric acid being converted in the soil into ammonia, or whether the

nitrogen is obtained as directly from nitric acid as from ammonia. Boussingault appears to have set this matter at rest by some carefully conducted experiments, by which he distinctly shows that plants assimilate nitrogen directly from nitric acid.

Again, there is no element which enters into the composition of plants more slow in combining with other elements than nitrogen; otherwise, the unlimited supply which we have of it in the atmosphere might be turned to good account. From the researches of Schoenbein, however, we learn that when "the oxygen of the air has undergone that mysterious transmutation into ozone it unites with nitrogen more readily, forming nitric acid;" and this ozone, we learn farther, is discovered always when organic matter enters into decomposition in a moist soil, well permeated by air.

The affinity of the oxygen of the atmosphere for nitrogen also becomes greater when air is made to pass through porous bodies that have been rendered alkaline, as has been shown by the interesting experiments of Mr. Claëy. Nor should we forget the services of M. Barral in this field of research.

He has shown that the rains replenish the soil always with ammonia and nitric acid from the atmosphere. He has several times called attention to the influence of porous bodies in producing nitrates, which is also one of the valuable effects of the liming of land. He has proved by direct analysis that drainage, by rendering the soil more permeable to air, facilitates the production of nitrates—an effect produced also by the cultivation of the soil more or less deep, which renders it more porous. He has objected to the use of the sulphate of iron as a fixer of ammonia, because it changes the alkaline carbonates of the manure into sulphates, which have not the same action in aiding the production of the nitrates. Such, then, is the state of our knowledge on this important subject.

Let us, then, apply these principles to practice. We have been in the habit, for some years, of mixing, during summer, our summer-made manure with earth, which is generally composed of decayed weeds, wrack, road scrapings, &c. The practice was generally con demned by practical men as entailing unnecessary labor in the mixing—all the advantages of mixing being obtained (they said) by forming a manure-heap and carting on it. We always found that the fields or parts of fields to which we applied the mixture produced larger crops than we expected, both the first year and the year after, and we have therefore continued the practice.

When organic matter is in a state of decomposition under the free influence of the air, nitric acid is produced, and this process is called nitrification. It goes on naturally in the soils in warm climates—in India, Peru, Spain, &c.; and the nitre is produced so rapidly and so abundantly in some places as to form nitre-beds, from which it is obtained for commerce. In more temperate regions the presence of fermenting organic matter, such as ordinary farmyard dung, is necessary for the production of the nitric acid; and it is found that when a heap has been formed of earth and dung, and, after a time, the whole of the nitric acid washed out from it, there is more nitrogen obtained than was found in the materials before they were mixed. The same thing takes place in the soil that has been well manured, as in the heap of earth and dung. The more manure we add to our soils, the more nitrogen do we draw from the air and convert into nitric acid. Hence it is that a soil in a high state of fertility will produce comparatively a larger crop, with an equal quantity of manure, than a soil that is out of condition—the increase of crop being due as much to the hourly-formed nitric acid as to the elements of fertility already existing in the soil.

What a lesson do farmers learn, also, from the scientific facts above stated as to the mixing of their composits! Lime and earth are the most common ingredients of composts on our farms. The lime, while it facilitates the decomposition of the vegetable matter in the earth, adds some valuable salts to the heap (such as the nitrate of lime) by causing the constituents of the air and earth to unite in different proportions, forming nitric acid and ammonia. This is the reason M. Barral gives for the good results which are obtained for several years, with but small doses of manure, from soils that have been limed. Alkaline substances also facilitate the formation of nitric acid, and might therefore be added, with advantage, to our compost-heaps. It is well known that common salt produces, in many districts, no effect at all when applied to the soil; but, strange enough, if it be formed into a compost with earth, and turned repeatedly, its effects on the crop are most marked. In some districts salt is always used as an ingredient with lime in a compost. In those cases where it is not required in the state of chloride of sodium as food for plants, if time be allowed till it is resolved into its elements, its alkaline base becomes of immense service in aiding the production of nitric acid. What is done so slowly in the soil is effected more rapidly in the compost-heap by the repeated turnings.

From the effects produced by allowing air to pass through porous bodies containing some alkaline substances, mentioned above, we learn one of the great advantages of deep cultivation and thorough pulverization of the soil. The oxygen of the air becomes *ozonified*—unites more readily with the nitrogen, forming nitric acid, which combines with the alkali present, and gives us a most valuable manure—a nitrate.

Large sums are now being offered for the substitutes for guano. We are of opinion that farmers should not look too much beyond their farms for that substitute; for we are convinced that the time is not far distant when, by the skilful application of scientific principles, they will find that substitute in the nitrogen of the air and in bones.—*Correspondence of the Highland* (*Scotch*) *Journal of Agriculture.*

THE INORGANIC FOOD OF PLANTS.

The salts which plants take up from the soil in which they root, or the water in which they live, or which a parasite takes from the stem upon which it leans, are made use of by them either in their original form or after a decomposition, and then consumed in the form of the products of that decomposition.

When gypsum is taken up by a plant for the use of its sulphur, which is reduced from the sulphuric acid, in order to make up the sulphurous ingredients of the plants, the lime is evidently separated from the sulphuric acid and passed into another compound.

Phosphates, on the contrary, which the plant receives from the soil are found as such afterwards in the plant, and especially in the seeds. The principal portion, at least, has undergone no decomposition. Whenever there is lack of phosphates in the soil, experience has taught that the yield of grain and of wine will be lessened. All goes to show that the absence of phosphates prevents the formation of albuminates. All albuminous substances, after ignition, leave some ashes which in every instance contain more or less phosphates, which cannot be extracted from the albuminate without complete destruction, except in a very few cases. The reason why, without the presence of phosphatic salts, no albuminous compound can form, is not sufficiently known. For even supposing, with Mulder, that the albuminates (protein-compounds) contain phosphorus among their elements, this does not explain the necessity of the presence of phosphates in such comparatively large proportion as they are found in the seeds.

There are other salts which are absorbed by plants without undergoing any further decomposition. Thus many maritime plants, and the *Tamarix gallica*, contain a large proportion of sulphate of soda; *Tropaeolum majus*, a large quantity of sulphate of potassa; many of the *Equisetaceæ* contain a large proportion of gypsum; *Borago-officinalis*, saltpeter, &c.

As an exception only are the carbonates or silicates found to any considerable extent. These salts are decomposed, their bases uniting with other acids with which they are brought into contact, while the acids are set free. Evidently the carbonates are needed by the plants only for their bases, since there is opportunity enough for them to take up carbonic acid in the free state. It is different as to the silicates, for here the acid also is of importance to the plant. Silicic acid is essential to the life of the grasses, equisetaciæ, &c., which thrive only upon a soil offering a considerable quantity of available silex. In the plants the acid is deposited as such, for it is but a small proportion that can be demonstrated as being present in the form of a silicate.

The plants of the shore and sea-weeds generally contain chlorides, (principally chloride of sodium,) which, at least in the majority of cases, appears to be an essential constituent. Whether the small proportions of chloride of sodium occurring in the plants of the interior be necessary to their existence, or must be considered as essential, is as yet hardly to be decided.

That the presence of bromides and iodides in not inconsiderable proportion in many maritime plants are essential to them is evident; for, while no organic substance has as yet been met with in the vegetable kingdom containing either bromine, iodine, or chlorine, it is also known that these bromides, iodides and chlorides, collect and accumulate in those plants, as is the case with phosphate in the plants of the interior of a country.

That the chloride of sodium is committed to supplying the sea-weeds with soda appears tolerably well settled, although the relation of the chlorine to the soda in living plants does not appear from the analysis of their ashes, owing partly to the faulty manner of conducting the same.

Organic acids are found united principally with potassa, which is represented by soda in marine plants. Next to these alkaline salts come the compounds of organic acids with lime, those with magnesia being still more rare. On the contrary, we find lime and magnesia much more frequently than potassa in the form of phosphate.

Iron and manganese are scarcely, if ever, absent in all plants, but only in small proportions, and of the latter especially, in the majority of instances, mere traces. Thus they are also never wanting among the constituents of any kind of soil. The minuteness of the quantity in which iron and manganese are contained in plants might lead one to suppose them to be merely accidental or non-essential ingredients, if it had not been demonstrated by the experiments of Prince Salm Horstmar that manganese is quite essential to the life of at least some plants, and by Verdeil that iron is a constituent of chlorophyl.

It has further been found by experiment that sickly-looking plants resume a healthy green appearance by being moistened with a solution of iron. Alumina appears a constitutional necessity in but few plants, as, for instance, a *Lycopodiaceæ*. It is rarely, if ever, found in the ashes, and then only in very minute proportion.

In the same manner in which the formation of albuminous compounds appears dependent upon the presence of phosphates, that of nitrogenous compounds, the carbohydrates, especially of cellulose, depends upon the presence of potassa or soda, lime or magnesia in the soil.

One of the bases to be mentioned here is ammonia—the oxyd of ammonium. It serves the plants to form its nitrogenous parts, and occurs in not inconsiderable quantities in their juice. There is no reason why this base, as far as it is not used up in the formation of nitrides, may not act in the same manner and for the same purpose as either potassa, soda, lime, or magnesia; for the great similarity in chemical and physical properties existing between the compounds of ammonia and of potassa renders a substitution of the one for the other to a certain extent very probable.

This assumed substitution, though not actually demonstrated by experiment, but yet highly probable, would justify very important conclusions. We could assume that plants which take up a large proportion of potassa form a soil rich in that alkali, and which they require for their growth, may as well live in a soil poor in that alkali, if it be replaced by ammonia. (Mulder.)

To determine the amount of bases a plant requires for its development, in which a substitution of this kind is probable, is impossible, because during the process of incineration the ammonia present is driven off, and cannot be traced in the ashes.

Liebig's theory, that certain plants must contain a certain amount of organic constituents; that therefore the sum of the oxygen of all bases is a constant one, though it cannot be demonstrated by experiment in the plants alluded to, is, nevertheless, not to be refuted. If we concede that certain bases are absolutely necessary to the life of a plant, it is obvious that there must be a minimum quantity of each one of these bases; and although it is not within the power of analytical chemistry to determine this minimum point, yet there is nothing in this to weaken the truth of Liebig's theorem.

As for the rest the substitution of ammonia for non-volatile bases suggested by Mulder is also in force as to the alkaloids, conine, nicotine, morphine, strychnine, which are undoubtedly able to a certain extent to replace the metallic oxyds, potassa, soda, lime and magnesia. Liebig himself first called attention to the fact that potatoes, when not properly supplied with alkalies and earths, produce solanine to a greater extent.

It is also a well known fact that *Hyoscyamus niger* is much more poisonous when grown on a pile of rubbish than when in good garden soil. Here there is evidently a replacement of potassa through hyoscyamin; for, while the rubbish contains a decided superfluity of lime and magnesia, it is poor in potassa, which on the other hand abounds in good soil. The more hyoscyamin therefore this plant contains, the less potassa will be found in the ashes. The supposition of Liebig, that in the barks of *cinchona* a like substitution may take place between quinine and cinchonine on the one hand, and metallic bases on the other, appears not to be confirmed by the latest experiments.—*Prof. Rochleder.*

ON THE PREPARATION OF BONES FOR AGRICULTURAL PURPOSES.

Professor Johnson, of the Yale Analytical Laboratory, gives the following method of reducing bones to powder, first communicated to the public by Mr. Pusey, the well known English agriculturist:

The process depends upon the fact that bones consist, to the amount of one-third their weight, of cartilage or animal matter, which, under the influence of warmth and moisture, readily decomposes (ferments or decays) and loses its texture, so that the bones fall to dust.

From the closeness and solidity of the bony structure, decay is excited and maintained with some difficulty. A single bone, or a heap of bones, never decays alone, but dries and hardens on exposure. If, however, bones in quantity be brought into close contact with some easily fermentable moist substance, but little time elapses before a rapid decay sets in.

So, too, if fresh crushed bones are mixed with sand soil, or any powdery matter that fills up the spaces between the fragments of the bone, and makes the heap compact, and then are moistened with pure water, the same result takes place in warm weather, though more slowly.

The practical process may be as follows: The bones, if whole, should be broken up as far as convenient by a sledge-hammer, and made into alternate layers with sand, loam, saw-dust, leached ashes, coal ashes, or swamp muck, using just enough of any one of these materials to fill compactly the cavities among the bones, but hardly more. Begin with a thick layer of earth or muck, and as the pile is raised pour on stale urine or dung-heap liquor enough to moisten the whole mass thoroughly, and, finally, cover a foot thick with soil or muck.

In warm weather the decomposition goes on at once, and in from two to six or more weeks the bones will have entirely or nearly disappeared.

If the fermentation should spend itself without reducing the bones sufficiently, the heap may be overhauled and built up again, moistening with liquid manure and covering as before.

By thrusting a pole or bar into the heap, the progress of decomposition may be traced, from the heat and odor evolved.

Should the heap become heated to the surface, so that ammonia escapes, as may be judged by the smell, it may be covered still more thickly with earth or muck.

The larger the heap, the finer the bones, and the more stale urine or dung-liquor they have been made to absorb, the more rapid and complete will be the disintegration.

In the heaps, horse dung or other manure may replace the ashes, &c., but earth or muck should be used to cover the heap.

This bone compost contains the phosphates of lime in a finely divided state, and the nitrogen of the cartillage, which has mostly passed into ammonia or nitrates, is retained perfectly by the absorbent earth or muck.

When carefully prepared, this manure is adapted to be delivered from a drill-machine with seeds, and, according to English farmers, fully replaces in nearly every case the super phosphate made by help of oil of vitriol.

FEEDING STATISTICS.

The following extracts from a communication to the (London) Farmers' Magazine, by the well known agricultural experimentalist, Mr. J. B. Lawes, of Rotheramsted, England, contains much of value to the cattle breeder, although, in regard to some points, a difference of opinion undoubtedly prevails extensively:

The first question to consider is, What is the probable amount of salable increase, or meat, that may be calculated upon as the produce of a given amount of ordinary good fattening food? The second is, What is the probable value of the manure? In offering a very few brief observations on these two points, I shall not attempt here to give any exact estimates of the comparative feeding properties of different foods, but merely state the average quantity of ordinary mixed foods of recognized good quality required to produce a given amount of gross increase or of carcass weight. I shall, however, give estimates of the comparative value of the residue remaining for manure from a given weight of a number of the most important of our stock-foods.

My own experiments show that oxen and sheep, fed liberally on good fattening food, composed of a moderate proportion of cake or corn, a little hay or straw chaff, together with roots or other succulent food, will yield over a considerable period of time one part of increase in live weight for from eight to ten parts of dry substances supplied in such mixed food. The quantity of dry substance of food required will vary between these limits according to the exact character of the food and other circumstances; but nine parts of dry substance of food for one of increase in live weight may be taken as a very fair average result for oxen and sheep with good food and good management. The dry substance of the fattening food of pigs contains much less indigestible woody fiber and a larger proportion of assimilable constituents than that of oxen and sheep, and in their case one part of increase in live weight should be obtained from the consumption of four to five parts of dry substance in their fattening food. By the "*dry substance*" of food is meant that portion which would remain after driving off, by a suitable heat, all the water which in their natural state they contain. For practical purposes it may be assumed that oil-cakes and foreign corn will, on the average, contain rather less than one-seventh, and home-grown corn, hay, &c., rather more than one-seventh of their weight of water, the remainder being the so-called "*dry substance*" of the food. In the same sense the commoner sorts of turnips will, on the average, contain more than nine-tenths, and swedes, mangels, &c., less than nine-tenths of their weight of water, the remainder being dry substance. Potatoes consist of about one-fourth dry substance and three-fourths water. From these data the farmer will be able to judge for himself whether or not he gets a proper increase in weight of live stock for the food consumed; and from comparative experiments he can decide whether or not he gets an adequately greater rate of increase by mixing with his other food some of the mixtures offered to him at £40 or £50 per ton. To aid him still further in his calculations on this point, it may be stated that, owing to the fact that during the fattening process the salable carcass increases very much more rapidly than the internal and other offal parts, it may be reckoned that nearly 70 per cent. of the gross *increase* of oxen and sheep fattening over a considerable period of time will be salable carcass. Calculations of a similar kind in regard to pigs show that of their increase in weight while fattening little less than 90 per cent. may be reckoned as salable carcass.

The valuation of the manure resulting from the consumption of different foods is founded upon estimates of their composition, and upon a knowledge, experimentally acquired, of the probable average amount of those constituents of the food valuable for manure, which will be obtained in the solid and liquid excrements of the animals. In the estimates of the value of the manure from different foods, given in the following table, I have based my calculations upon what I consider the average composition of several articles when of good quality:

Table showing the estimated value of the Manure obtained from the consumption of one ton of different articles of Food, each supposed to be of good quality of its kind.

Description of Food.	Estimated money value of the Manure from one ton of each Food. £	s.	d.
1. Decorticated Cotton-seed cake	6	10	0
2. Rape cake	4	18	0
3. Linseed cake	4	12	0
4. Malt-dust	4	5	0
5. Lentils	3	17	0
6. Linseed	3	13	0
7. Tares	3	13	6
8. Beans	3	13	6
9. Peas	3	2	6
10. Locust beans	1	2	6(?)
11. Oats	1	14	6
12. Wheat	1	13	0
13. Indian corn	1	11	6
14. Malt	1	11	6
15. Barley	1	9	6
16. Clover hay	2	5	0
17. Meadow hay	1	10	0
18. Oat straw	0	13	6
19. Wheat straw	0	12	6
20. Barley straw	0	10	6
21. Potatoes	0	7	0
22. Mangolds	0	5	0
23. Swedish turnips	0	4	3
24. Common turnips	0	4	0
25. Carrots	0	4	0

It will be seen how enormously the value of the manure from one ton of different foods varies according to the composition of the food itself. Now, from the actual analyses that have been made of several of the expensive "condimental" compound foods, as well as from a knowledge of the chief articles used in their manufacture, it may be safely asserted that a ton of few, if any of them, would yield a manure of anything like the value of either of the first nine articles in the above list. In the case of the majority of these new foods, the value of the manure, from a ton of the food, would certainly be much less than that from a ton of any one of these nine articles.—*J. B. Lawes.*

DO ANIMALS CONSUME FOOD IN PROPORTION TO THEIR WEIGHT?

The most decisive experiments bearing on this question are those of Mr. Lawes. These experiments were made to determine the "comparative fattening properties of some of the most important English breeds of sheep." The breeds selected were the Sussex Down, the Hampshire Down, the Leicestershire, the Cotswold, and half-breed wethers and half-breed ewes.

The sheep for these experiments were selected by good judges from the best flocks in England. Mr. Lawes says: "Letters were written to breeders of eminence (those being generally selected who had obtained prizes for their sheep) requesting them to select fifty wether sheep born the same year, and representing fairly the breed required for the experiment. No limit was set upon price. The sheep were sent, about the month of September, to the farm, and they were kept upon ordinary food until the middle of November. At

this time the sheep were about nine months old, having been lambed about the February preceding."

At the commencement of the experiment in November, the sheep being about nine months old, the fifty Cotswolds weighed, on an average, $119\frac{3}{4}$ lbs.; the Hampshire Down, $113\frac{1}{2}$ lbs.; the Leicesters, 101 lbs.; the half-breed wethers, 95 lbs.; the half-breed ewes, 91 lbs.; and the Sussex Downs, 88 lbs. each.

The experiment lasted from five to six months, the sheep being weighed at the end of every four weeks. The quantity of food consumed was accurately ascertained.

The following table shows the average amount of food consumed weekly by each sheep:

	Oilcake.		Hay.		Turnips.	
	lbs.	*oz.*	*lbs.*	*oz.*	*lbs.*	*oz.*
Cotswold	8	1	6	14	113	4
Hampshire	8	0	7	0	106	10
Leicester	5	14	5	$9\frac{1}{2}$	83	12
Half-breed wether	5	14	5	$9\frac{1}{2}$	82	$14\frac{1}{2}$
Half-breed ewe	5	$9\frac{1}{2}$	5	$4\frac{3}{4}$	78	0
Sussex	6	3	5	14	79	1

The average rate of increase per head per week was:

	lbs.	*oz.*
Cotswolds	3	$2\frac{1}{2}$
Hampshire	2	12
Sussex	2	$1\frac{3}{4}$
Leicesters	2	1
Half-breed wether	1	14
Half-breed ewe	1	$13\frac{1}{4}$

By ascertaining how much water there was in the quantity of food consumed by the different breeds, we are enabled to see exactly how much dry food was eaten. This was done. Then, by taking the weight of the sheep at the commencement and at the end of the experiment, we are enabled to determine their mean weight.

Thus, if a sheep weighed 100 lbs. at the commencement of the experiment, and 150 lbs. at the conclusion, we should call its mean weight 125 lbs. Now, if this sheep eats 3 lbs. of dry food per day, we say that the amount of food consumed by 100 lbs. of live weight would be 2 lbs. 4 oz. per day. (If 125 lbs. eats 3 lbs., 100 lbs. will eat 2 lbs. 4 oz.) Knowing the weight of the sheep, then, at the commencement and at the end of the experiment, and also the quantity of total food consumed, (and the exact quantity of dry matter which it contained,) we are enabled to calculate how much 100 lbs. of live weight of the different breeds consumed of dry food per head per day. The result was as follows:

	lbs.
Cotswolds	2.16
Hampshire	1.01
Sussex	2.01
Leicester	2.15
Half-breed wethers	2.02
Half-breed ewes	2.03

In commenting on these figures Mr. Lawes remarks: "Although there is a general impression among agriculturists that large sheep eat proportionally less than small sheep, it is evident that equal weights of sheep consume equal amounts of food."—*Genesee Farmer.*

COTTON SEED CAKE.

The following remarks on the subject of cotton cake, made by Professor Voelcker, of the Agricultural College of Cirencester, England, will be read with interest:

There are several specimens of cotton cake on the table. There is very little value in the husk itself; the difference in the two kinds of cotton cake, then, arises from the different modes in which they are made. The one, the decorticated cake, is made from the kernel; the other kind is made from the whole seed. The difference in composition of the two kinds of cake is very great. The decorticated cotton cake contains sixteen per cent. of oil, (more than any other description of cake,) while the whole seed cake contains only six per cent.

The proportion of albuminous or flesh-forming matters in the decorticated cake amounts to forty-one per cent.; in the whole seed cake it is only twenty-three per cent.—just one-half. So with respect to the other constituents. The proportion of woody fiber is very much larger in the whole seed cake than in the other. The husk in the whole seed cake, for a long time, was a great impediment to the general use to which cotton cake is now applied in this country.

The difference in the value of the two descriptions of cake is so great that I almost think two tons of the oil cake made of the whole seed does not go further than one ton of the best decorticated cotton seed cake. Moreover, there is a certain danger in using the whole seed cake. Several cases of so-called poisoning have been brought under my notice within the last year or two. Animals that have freely partaken of the whole seed cake have died suddenly, and people have imagined that there was something injurious in the husk.

There is nothing poisonous in the husk of the cotton seed, and, when given judiciously, no injury will result; but if animals are supplied with an unlimited quantity of dry food with the whole seed, there is danger. The hard husk is indigestible, and may roll together in such large masses that inflammation of the bowels will ensue. There is no such danger, however, in the use of decorticated cotton cake. The decorticated cake occurs of various degrees of quality; and allow me to observe, with respect to all kinds of cake, that not only the composition, but even, in a higher degree, the condition of the cake, determines in a great measure its value.

"Some time ago I was very gratified in finding what great care Mr. Stratton, of Broad Hinton, the celebrated short-horn breeder, takes in selecting the very best of American barrel cake for his stock.

"In examining the different cakes, we ought to examine particularly their condition. The freshest cotton cake is as yellow as mustard. I hold a piece of cake in my hand, the exterior of which is brown, but if I cut away a portion you will observe that the interior is bright yellow—very different from the part that has been exposed to the air. This was an excellent cake when we first got it, for feeding purposes, and we are feeding it extensively on our farm at Cirencester. When we first had it, it was of a bright yellow color, but you observe how it has since changed. From this we may learn a very useful lesson—that we may take the color as a guide to the condition and age of the cakes. If we are presented with a cake which is as brown as the specimens before me, and if you find, on cutting it, that the brown color has penetrated deep into the interior, we may at once conclude that it is a stale, old cake. The deeper it has penetrated, the older the cake, and the more it has suffered by bad keeping. If it is kept in a damp place, its color and condition are rapidly deteriorated."

Composition of Cotton seed Cake.

	Decorticated.	Whole seed.
Water	8.29	11.34
Oil	16.05	6.18
Albuminous compounds, (flesh-forming matters*)	41.25	23.72
Gum, mucilage, sugar, &c., (heat-producing substances)	17.44	30.98
Woody fiber	8.92	21.24
Mineral matter, (ash)	8.05	6.54
	100.00	100.00
* Containing nitrogen	6.58	3.79

Upon this subject the editor of the Working Farmer remarks: "This table gives a proximate analysis of the cotton seed cake, after the oil has been expressed, and it does seem to be a neglectful practice on the part of the planters of the South, as well as of the North, to disregard its value for feeding purposes. Can it be possible that it can pay a freight to England and then be used for feeding cattle, and not be of sufficient value at home for similar purposes? A large factory is established at Providence, Rhode Island, for its manufacture. The cotton seed is carried from Charleston and elsewhere to Providence, subject to heavy freight and expenses, and probably two or three profits before it reaches the manufacturer. He is enabled, with workmen at high cost, to decorticate the seed, express

the oil, and then ship the cake, subject to another freight and probably to two or three dealers' profits, before it reaches the farmer, and he finds it to his interest to use it. Is it possible, under these circumstances, that it could not be used in Carolina to greater advantage than in England?

NUTRITIVE VALUE OF DIFFERENT PASTURE PLANTS.

The following table and observations on the nutritive value of various pasture plants, as determined in England and Scotland, is derived from a Prize Essay by Mr. Fulton, in the Journal of the Highland Agricultural Society, (Scotch,) July, 1859:

Scientific names.	Common names.	
Phleum pratense	Timothy-grass	27.71
Cynosurus cristatus	Crested dogstail	22.71
Dactylis glomerata	Cocksfoot	17.58
Lolium Italicum	Italian ryegrass	17.36
Poa pratensis	Smooth-stalked meadow-grass	16.56
Festuca duriuscula	Hard fescue	16.16
Trifolium pratense perenne	Cow-grass	15.71
Holcus lanatus	Yorkshire fog	15.41
Lolium perenne	Perennial ryegrass	15.38
Medicago lupulina	Yellow clover	13.40
Poa trivialis	Rough-stalked meadow-grass	13.12
Trifolium pratense	Common red clover	12.72
Trifolium repens	White clover	11.94

Festuca pratensis, (meadow fescue,) one of the best grasses, as well as other fescues, have been overlooked.

If any doubt the accuracy of the above results, or desire further proofs, they can appeal to the highest authorities in the matter—the cattle. Let them sow the cultivated natural and artificial grasses separately in a field, as the writer has done, and they will find that the cattle will eat most of the other grasses almost out of the ground before they will touch perennial rye grass and white clover.

To produce rich and productive pastures, we must anticipate nature by thoroughly stocking the land with a good variety of the best grasses, such as are palatable and nutritious; that resist drought and grow at low temperatures; that are large growers and spring quickly after being cropped. It is necessary to give a liberal allowance of seed, in order to prevent the growth of worthless and injurious indigenous plants; and, owing to their gregarious habits, grasses plant closest and thrive best when in considerable variety.

For one year in grass the following can be recommended:

Common ryegrass	½ bushel.
Italian ryegrass	1 bushel.
Yorkshire fog	2 bushels.
Timothy-grass	5 pounds.
Red clover	8 pounds.

CHAFFED HAY, STRAW, ETC.

The cutting of hay, straw and corn stalks, as food for cattle, is now in very general use in this country, and we believe it to have been fully ascertained that nineteen pounds of cut hay will take the place of twenty-five pounds in the long state. Our machines for performing this operation usually cut from one inch to an inch and a half in length. The English farmers are supplied with a different class of machines, cutting less than a quarter of an inch in length, and thus forming what they call chaffed feed. This practice is becoming very general, and, in connexion with machines for pulping roots, is quite revolutionizing the old practice.

We cannot conceive why the saving referred to above, of six pounds of hay in twenty-five, may not be augmented by cutting the hay shorter. If it is true in the one case, it must be true in degree all the way down to the chaffed condition.

We find in the *Irish Farmers' Gazette* the following question: "I wish to be informed if there be some great breeder or rearer of cattle in England or Scotland whose method consists in steaming chaffed straw and turnip tops, the offal, as it were, of the farm, and giving the mixture to milch cows, steers, &c.? Who is he, and what measure of success seems to have followed the practice? Be good enough to state precisely what you know of it." To

this the editor replies: "The practice is so general and useful with many farmers in both England and Scotland that it is not necessary to name any one in particular. Suffice it to say that it is a very common practice, and profitable."—*Working Farmer.*

BUCKWHEAT AS FOOD.

From an investigation conducted by M. Isidore Pierre, of France, "On the value of buckwheat as an article of food," we derive the following statements. Buckwheat cooked products are equal to pure wheat bread as far as regards the phosphates or bone-making material and nitrogenous principles which they contain, and are superior to bread in fatty matters. The general yield of buckwheat, when cooked, is about three times the weight of the flour used, showing that such flour will retain forty to forty-one per cent. of water. Between different batches of ground buckwheat there is a great dissimilarity of composition—one batch containing nearly seven times as much nitrogen, twenty-five times the amount of phosphates and a hundred and fifteen times as much fatty matter, as another. The bran is the richest portion of the buckwheat, but cannot be digested by weak stomachs.

BROWN BREAD.

The *Comptes Rendus* of the French Academy of Sciences of Paris contains a very long paper, which is of some scientific and of more practical interest, on the art of making Bread. It appears that the bran of ground wheat contains an active principle of ferment, which has hitherto not been rightly understood by chemists, and to which the name of *céréaline* has now been given. This ferment can, we are told in the paper before us, be neutralized by the application of glucose, employed in a particular way; and being neutralized, the greater part of the bran becomes transformed into good flour. In other words, what in France is called bread of the second quality, which the common people are obliged to eat on account of its cheapness, (though they do so with a certain degree of repugnance,) can be done away with, and bread equal to that of the first quality, which is consumed by the better classes, can, without increase of expense, be substituted for it. Thus the new system seems to be of great utility, and it is desirable that our bakers should inquire into it. The bread produced is represented to be very palatable and wholesome. In the course of the experiments which the new plan necessitated, a curious chemical fact was discovered—namely, that the dark color of bread of the second quality is not caused, as has always been supposed, by the presence of bran in the flour, but by a peculiar fermentation of the flour. The discoverer of the improved system is M. Mège Mouriès.

THE VALUE OF SORGHO AS A FORAGE PLANT.

The Sorgho at first was praised beyond measure; then it was declared to be poisonous, and that it diminished the quantity of milk. In short, after repeated experiments made by very distinguished farmers, it is considered as one of the best fodder-plants we can cultivate. In his experiments made in 1856 and 1858, M. F. Peer has obtained the following results:

In the month of May a field was sown, hoed and cleaned, as usual. The plants, 15 centimetres distant, soon began to spring up. At the end of July they were cut down, and given as fodder to four cows, who ate it greedily. These cows were entirely fed on it from the beginning of August till the beginning of October, a period of sixty days. The quantity of milk was the same during this period. The ration of each cow was about 75 kilometres of the stalks of the herb, or 300 kilometres for the four cows; and a field of 26 acres furnished this quantity for sixty days.

M. Peer concluded from these experiments that sorgho, two metres high, can produce, without exaggeration, 72,000 kilometres the hectare. He cut down the sorgho several times, but the last, in August, produced only thin stalks for the sheep. This plant can be cut several times in the year only when the soil is rich.

In August, the lower part of the stalk had become stringy; these were cut down and mixed with the leaves, so that not a blade was lost. M. Peer considers a single cutting of sorgho worth four of clover; that is to say, a hectare of sorgho is worth more than two hectares of clover as food for cattle.

As yet, the sorgho has been attacked by no insect, and it is ready for the cattle at the time when the other plants are dried up by the sun. These are two great advantages.

Sorgho cultivated on some lands imbibes poisonous qualities, for which it has been rejected by certain farmers. The accidents caused by sorgho might have been prevented at first by prudent and judicious experiment. If it produces a bad effect, it may be mixed with other ingredients. If it is not injurious, administer it confidently, and this is nine-tenths of the case.—*From the "Journal (*June No., 1859,*) de la Société Centrale d'Agriculture de Belgique."*

TREES—DISTANCE APART TO SET THEM.

Messrs. Hooker & Co. have published the following directions for setting trees in orchards and plantations, and the number of trees and plants required to fill an acre:

Name of plants.	No. of feet apart each way.	No. per acre.
Standard apple trees	30	48
Dwarf apples	6	1,210
Standard pears and cherries	20	110
Dwarf pears, dwarf cherries and quinces	10	436
Apricots, peaches, nectarines and plums	20	110
Currants, gooseberries and raspberries	4	2,722
Blackberries and black-cap raspberries	8	681
Grape-vines	12	302
Strawberries in rows, 2½ feet apart, plants 1 foot apart in the row		17,408
Strawberries for market garden, 1 foot by 4		10,888

ON THE PROTECTION OF PLANTS FROM THE FROST.

M. Boussingault has devoted a long article in the *Annales de Chimie et de Physique* to the preservation of plants from frost, by filling the air with smoke. This is not recommended on nights when the thermometer at a distance above the soil indicates a temperature below 32°, for it would then have no effect; nor on windy nights, for there is no frost; but it may possibly be found of service in protecting fruit-trees and delicate plants from the late frosts of spring, by which their blossoms are so often destroyed.

ON THE PRODUCTION OF OPIUM IN THE UNITED STATES.

Mr. E. Weiss, who has devoted considerable attention to the cultivation of the poppy (with a view of preparing opium therefrom) in Southern California and some other portions of our country, publishes the following facts and suggestions relative to the subject:

The species of poppy cultivated in the East for the sake of its sap (opium) is the so-called garden poppy, or *papaver somniferum*, of which there are two kinds—the common white and the common black poppy—both considered equally rich in sap. The pods of the white poppy are larger, whereas the black is more abundant in seeds, but then its oil is inferior to that of the former. The black poppy contains more morphine and the white more narcotine; then again, the white poppy, with round or compressed pods, contains still less morphine than the one with oval pods. The poppy with brownish purple flowers is said to contain the most morphine. The poppy with filled blossoms is not so rich in sap as the one with simple blossoms.

According to information collected on the spot, the cost of the production of opium in Egypt is 60 cents, and in Anatolia (Asia Minor,) 75 cents the pound. The greater cost in the latter country comes apparently from its higher latitude and the less congenial climate. In British India opium is still a monopoly of government. The leaseholders of certain districts are bound to produce and to deliver annually a given quantity of this drug to the Honorable Company at the fixed price of $150 the chest of 140 pounds, which leaves still a small remuneration to the producer. This traffic amounts to over 50,000 chests a year, and the prices of the drug in the Presidencies vary from $500 to $700 the chest, according to quality and demand. The cost of superintending and collecting this important revenue absorbs near a million and a half pounds. Opium is consumed all over India and the Malayan Archipelago. In Java the sale of this drug is a monopoly of the Dutch Company.

The value of opium in the Eastern market varies from $4 to $6 the pound, according to quality and demand; whereas the cost of production, as before stated, hardly reaches a dollar a pound.

The poppy suffers nothing from insects, and its flowers give rich food to bees. The oil of the white poppy is considered in Europe the best after the olive oil. The poppy wants calm, warmth and a loose soil; manure agrees with it on the best of lands. A subsoil of clay is prejudicial to its growth. The poppy thrives well after fallow produce, which leaves

a clear soil, such as treffles, cabbage and potatoes; on a rich soil it may be cultivated also, in continuance. After the poppy crop a crop of barley can be raised the same year. Wet does not agree with the poppy, and a rain of two days' duration at the maturity of the plant will spoil the whole opium crop. The best opium produced in Asia Minor comes from the elevated plain (plateau) in the vicinity of the town of Kara Hissar. The soil of this plain is of volcanic origin, belonging to the trachytic formation. During three months this plain is covered with snow mostly every winter; the great heat there comes, but after the opium crop.

In the districts of Benares and Behar, in the valley of the Ganges, the poppy is sown in November, in Upper Egypt in January, and in Lower Egypt at the time of the spring equinox. The soil must be ploughed and harrowed carefully before the poppy can be sown; also, the application of pulverized manure (guano) is recommended. To an acre but two pounds of seed are required, which are mixed with earth, in order to throw them thin and regularly enough. As soon as the weeds spring up they must be rooted out carefully, and when the young poppies stand too close they must be thinned so that every plant has about nine square inches room and an easy access to facilitate the collection of the sap. This is done when the plant has reached the height of two or three inches; better not too early, in order not to disturb it in its growth. The wider the plants stand apart the more capsules they drive; yet this must not be carried too far, especially on a loose ground, because the plants would be exposed to be levelled by the wind. A month after the sowing the ground is hoed, and as soon as the blossoms show, the earth round the plant is heaped up. This must be done in dry weather. No pains should be spared in the tillage of the soil, as they will be amply repaid by the increase, and the improvement, too, of the sap of the plant.

The poppy plant throws out from four to six and more pods; half and often two-thirds of them are cut off, and only the first head or two, as being the largest, are left. After the fall of the blossoms, when the capsules or pods are filled with sap and have obtained their normal size—yet before they harden and begin to turn yellow—horizontal incisions are made with an instrument composed of four or five blades, united and shaped so that the rind of the pods cannot be cut through by this operation. Pereira says:—"A few days after the flower has fallen, men and women repair to the fields and cut the heads of the poppy horizontally, taking care that the incisions do not penetrate the internal cavity of the shell. A white substance immediately flows out and collects in tears on the edge of the cuts. In this state the field is left for twenty-four hours, and on the following day the opium is collected by the same people provided with large blunt knives. Each head furnishes opium but once only, and that to an extent of but a few grains."

When the pods give no more sap, they are cut off and dried for the seed and the oil they contain; but, for sowing, these seeds are of no use, because the plants they produce are weak, poor in sap and of inferior quality, too; therefore the seeds for sowing must be taken from unhurt pods. To this purpose large capsules of orange shape are selected, which are dried in the shade, then filed on strings by the stem and hung up in a dry room with not too much draught, where they remain unopened till seed-time. Seeds of the last gathering are preferred to those of the year before.

In Turkey, immediately after the pods are removed, also the stems and leaves are collected and well boiled in water on the spot. The decoction, without being strained, is poured off into pans along with the sap of the pods boiled down to the consistency of pitch, formed into loaves of about one pound weight, and wrapped into poppy leaves to keep them from sticking together. The decoction of the plant is said to contain as much morphine as the sap of the pods; still the "Theriakees," (Turkish opium-eaters,) who, of course, must be connoisseurs, prefer the latter, *i. e.*, the opium in drops. One day's ripening too much will greatly diminish the quantity of morphine in the sap of the pods, and probably also of the whole plant. The sooner, therefore, the incisions are made, and the quicker the operation is ended, the better the opium, *i. e.*, the richer in morphine it will be.

Smyrna opium, as above stated, composed both of the sap obtained by incisions and the decoction of the plant, contains, in the mercantile quality, about nine per cent. of morphine only, while the sap of the pods is said to contain as much as fifteen. The composition consists of about two-thirds of the decoction and one-third of the sap of the pods; the former, also, must apparently be poorer in morphine than the latter.

The seeds of the injured pods are used for oil. The oil cakes of this seed are much liked by the cattle, and the stems and leaves may be used as a manure or fuel, their ashes containing much alkaline matter.

A gentleman farmer at Winslow, (England,) made, in 1821, an experiment with the poppy on four and a half acres of land, which gave the following result:—60 lbs. of dried opium, 7½ gallons of oil, and the oil cakes. In this experiment the stems and leaves were not used. At about the same time a similar experiment was made in Erfurt, (Germany,) the result of which was the average gain of one grain (480 to the ounce) of opium from every pod. Calculating nine square inches of land and two poppy heads to every plant, the

results of the latter experiment coincide very nearly with the former. This bad result is not to be wondered at, but rather the funny idea of the European experimentalists, in their wet and changeable climate, to enter into competition with the producers of opium in the sunny climes of the East.

Some twenty years ago an attempt to produce opium was made by a Dr. Webster Lewis, of Lewisburg, York county, Pennsylvania, who informs the public (through the *Medical Recorder* of 1834) that after many unsuccessful experiment the has fallen on a mode of cultivation both easy and profitable, and that good poppy seeds may be had from him. It seems he was not successful in his poppy-seed trade, to judge by the continued importation of this drug here and in Boston. Pennsylvania is not a whit better situated, or, rather, is as ill-favored by nature, for the production of opium as either England, France or Germany. In old Europe the poppy attains but three and a half to four feet in height, and the pods the size of a' hen's egg, whereas in a more congenial climate the plant reaches six feet and more, and the pods the size of a little child's head. Considering this, the fact will not be found astonishing that one acre of poppies in the East produces up to one hundred and thirty pounds of mercantile opium, and more, too.

Mr. Weiss states that the climate and soil in the vicinity of San Diego, California, are highly propitious to the production of opium—better, I dare say, than any part of Asia Minor; and the Pueblo Indians, under proper directions, are as well qualified as the Fellaheen, Hindoos or Osmanlees of the eastern hemisphere to attend to this new and also easy cultivation; so much more, as it wants neither chemical nor mechanical skill in the production of opium, unlike indigo, sugar, cotton, rice, &c. In the vicinity of San Diego, land, labor and cattle are at normal prices, yet unaltered by gold excitement and immigration. Any amount of opium produced there would find a ready market in the capital of the State, whose population contains a very large number of Chinese, and whose commercial relations with China and Japan are improving daily.

ON THE CULTIVATION OF OPIUM IN FRANCE.

M. Roux, Professor of Botany at the Naval School of Rochefort, France, has recently contributed an interesting paper to the French Academy, on the cultivation of the poppy in France for the purpose of extracting opium. His first researches on this subject date from 1851, but were more especially continued by him during 1856, 1857, and 1858, on eight different kinds of poppy. His results are stated as follows: 1. The Indian poppy furnishes a considerable quantity both of opium and seed; the cultivation of this vigorous species might be tried in those departments of France where the oil of the black garden poppy is a staple produce. The Indian poppy may be easily acclimatized in France. A quantity sown in October, 1857, has succeeded perfectly, and the young plants resisted a cold of 10 degrees centigrade (18 degrees below Fahrenheit's freezing point) in the following winter. This cold proved equally harmless to the white, black and red species, which were sown about the same time. 2. The two latter produce the best opium, and their juice is much richer in morphine than is the case with the opiums of commerce. 3. A man can collect 100 grammes of opium in fifteen hours; and if women and children, who are so often in want of employment in the country districts, were employed in this task, the opium necessary for medical purposes might be entirely grown in France. 4. The growing of opium might become very profitable in France, where poppy oil is manufactured to the amount of from 25,000,000f. to 30,000,000f., and where it would, consequently, be easy to add a new branch to that trade by the extraction of opium; and it might even, in course of time, become an article of exportation. Home-grown opium has been tried, at M. Roux's request, by M. Duval, first chief Navy surgeon at Brest, and found to answer very well, owing to the quantity of morphine it contains.

WEEDS.

If we consider the immense number of weed-seeds that are mingled among our clover and other seeds, we would be at no loss to account for the growth of these pests in our fields. Professor Buckman, to whom the thanks of agriculturists are due for the devotion of his talents and time to this subject, discovered "in a pint of clover-seed, 12,600; in broad clover, 39,440; and two pints of Dutch clover yielded severally 25,560 and 70,400 weed-seeds. Supposing these samples to be sown, here were seeds enough to stock the land with weeds for many years."

"The farmer often goes to the cheapest market, and gets weeds for corn, and so pays exceedingly dear for what he considers a cheap bargain."

If we take into account the great fecundity of some weeds, we will not feel the least

astonishment at the increase of the plants when the seeds are sown, and the plants allowed to arrive at maturity.

Professor Buckman has counted 8,000 seeds in a single plant of black mustard, and in a specimen of charlock 4,000 seeds. The common stinking chamomile produces 46,000, and the burdock 26,000 seeds; and the seeds of a single plant of the common dock produced 1,700 little docks. It is a notorious fact that a great deal of the ryegrass seed of commerce in Scotland is raised in some of the worse farmed districts, where weeds are certainly not an exception; and as it is, in many instances, bought and sown by the unsuspecting farmer without being properly cleaned, it is no wonder that he is often surprised and annoyed, on turning up his lea, to find the field overrun with weeds of all descriptions, though he had been most particular in cleaning his land before sowing it down.

Another means of propagating the growth of weeds by seed is the wind, which carries to immense distances winged seeds, such as those of the thistle. Here again the remedy, or rather the prevention, is in the hands of the farmer. Such weeds should never be allowed to come into seed. All the fields in the farm should be gone over at least twice in the season, so that not a single plant might escape. We have practiced for some years the cutting of thistles close by the ground, or rather under its surface, and putting a little common salt on the root about the end of May. We have found this to be effectual in preventing the growth of the plant the same season again, and in most cases the weed has been killed by the application, so that we have never been troubled again with it.

Another means of spreading weeds over the farm is the dung-hill. Many farmers pursue the laudable practice of cutting the grass along their hedge and ditch sides, and putting it into their dung-hills, either to be consumed by animals or to be mixed among the dung. This is very good if the grass was only cut in time—that is, before the weeds growing amongst it were in seed; but it too often happens that this operation is performed after the turnips are all sown, and the men having nothing else to do before harvest. By that time many weeds are in seed, which is scattered over the fields when the dung is applied to the land.—*Journal of Agriculture.*

DESTROYING OF WEEDS.

A single plant of the common groundsel will produce 6,500 seeds in one summer. The graceful corn cockle sheds 2,600 productive seeds; and the red poppy, which diversifies our corn fields and looks so gay upon our hedges, produces 50,000 minute but vital seeds. The corn sow-thistle launches out into the wind its 20,000 flossy parachutes, bearing the germinating car-like speck to undulate with every breath of air, and take root far away. The common dock lets fall its 13,000 solid grains, each destined to shoot down an exhaustive tap-root into the soil. Dandelion produces nearly 3,000 seeds, each furnished with an inimitable apparatus for a distant flight. The cow-parsnip, if neglected, will produce 5,000 plants; the meadow-scabious, 4,000; the mayweed, 45,000; the daisy, 13,500.

Nor is it sufficient to cut down their bearing plants, and leave them to dry on the dung-heap or wither on the ground. The sap in the stem and leaves of the cut-down plants still mounts up to and nourishes the seed. Nor is their wondrous vitality less remarkable. If the ground be trenched three or four feet deep, there will appear upon the surface a dense crop of weeds of a different kind from any observed before. They may have lain hidden for years, but when exposed to the air, and rain and sun, the little spark of vitality within germinates as if the seed had freshly fallen. It is intolerable, that an indolent farmer should be permitted to poison his neighbor's fields. If he is lost to all sense of the injury he inflicts upon his own produce, he should be coerced to extirpate these enemies for the sake of others, whose property and labor are deteriorated by his carelessness.

Alexander II of Scotland denounces that man to be a traitor "who poisons the king's lands with weeds, and introduces a host of enemies." Whoever was found to have three heads of the common star-wort among his corn, was fined a sheep for each stalk. In Denmark the farmers are bound by law to destroy the corn-marigold, and in France a farmer may sue his neighbor who neglects to eradicate the thistles upon his land at the proper season. A law is already in operation in Australia to the same effect, and it is proposed to introduce a similar enactment into the Canadian code. Nor have suggestions for such enactments been wanting in England. A clause enforcing the extirpation of weeds in hedges, or along the sides of roads, passed through the House of Commons, but it was for some reason negatived by the Lords.—*North British Agriculturist,* p. 1085.

INFLUENCE OF EXTREME COLD ON SEEDS.

Some experiments, more thorough and satisfactory than those of Edwards and Colin, have been made during the present year by Professor Eliè Wartman, of Geneva, on the

influence of extreme cold on the seeds of plants. Nine varieties of seeds, some of them tropical, were selected. They were placed in hermetically-sealed tubes, and submitted to a cold as severe as science can produce. Some remained fifteen days in a mixture of snow and salt; some were plunged into a bath of liquid sulphuric acid, rendered extremely cold by artificial means. On the 5th of April they were all sown in pots placed in the open air. They all germinated; and those which had undergone the rigors of frigidity produced plants as robust as those which had not been submitted to this test.

ON THE GERMINATION OF SEEDS.

From a Memoir contributed to the *Journal de la Société Imperiale d'Horticulture* on the "Germination of Seeds," by M. Charles Appelius, seedsman of Erfurt, we derive the following abstract: "The value of a sample of seeds is often determined solely by their specific weight and density."

This method is no doubt good, but not infallible; besides, the weight of the same kind of seed may vary from year to year, according to the manner in which it is grown. It may even vary upon the same plant; it does so particularly in an ear of maize, the grains situated in the centre of the ear of that plant having a greater specific gravity than those above or below. Now, the latest experiments of Dr. Hellriegel go to prove, first, that in accordance with the general opinion of cultivators the best formed seeds have the greatest specific gravity; and, in the second place, that the heaviest seeds produce the strongest plants.

Every one knows that in order to ascertain the specific gravity of seeds quickly and easily it is the custom to throw them into water, and to collect as the best those which, from their greater weight, fall to the bottom, whilst those which float are rejected as bad. However, too much confidence must not be placed in this method of proving seed by water. It may frequently mislead, particularly in the case of seeds in which the specific gravity differs little from that of the fluid. For example, those of cucurbitaceous plants, which are produced during cold seasons, float upon the water, and nevertheless germinate very well. It is known, too, says M. Appelius, that the seeds of these plants bear more female flowers than younger plants; that is to say, the plants are more prolific than those raised from seeds gathered in a cold season and planted shortly after they have ripened. Good seeds of the melon and gourd lose weight as they grow old; at first they will sink in water, and by the sixth year half of them will float, without having become bad. We conclude, therefore, in this case, as in many others, that trial by water is not a sure test.

In general the heaviest seeds are those which contain the most starch, such as those of cereals and leguminous plants, &c. The specific gravity of oily seed is often nearly the same as that of water, although in some cases they are heavier; as, for example, those of cabbages. The lightest seeds are those of umbelliferous plants, such as carrots, parsnips, chervil, aniseseed &c., and of composites, such as lettuces, scorzoneras, &c. In the first of these families the lightness of the seeds arise from the presence of an oil in the case which encloses the seed, and of air in the last. With a few exceptions all shining seeds are heavier than water.

Many cultivators, before buying seeds, test them by making them germinate upon damp blotting paper, at a temperature of 59° to 75°. This process is convenient and tolerably sure for the kinds which are quickly raised, such as clover, peas and cereals, but does not answer for those which require a long time to germinate. For these the best practical plan is to grow a sample in a pot. But even this will not always give a strictly correct indication of the germinating power of seeds, since the result depends, all other circumstances being equal, upon the care taken in sowing, the temperature of the air, the depth at which seed is sown and the time of the year, &c. Thus the pips of apples and pears almost always germinate badly and in very small quantities when trials are made of them in pots soon after they are ripe, whilst they answer perfectly if they are sown at the end of October or in March in beds in the open air. For this reason it often happens that a sample is pronounced bad when in reality it is excellent.

This is the case with the generality of woody plants, the seed of which come up the first year, conifers excepted.

The soil which is used to cover the trial seedlings also considerably affect the result. If, for example, the ryegrass seed (Lolium perenne) is sown in soil which retains moisture with average tenacity, and is buried one inch below the surface, seven-eighths of it grow in twelve days; if two inches, seven-eighths also grow, but in eighteen days; if three inches, six-eighths in twenty days; if four inches, four-eighths germinate in twenty-one days; at five inches, three-eighths in twenty-two days; and at six inches, the proportion of the seeds which germinate is reduced to one-eighth in twenty-three days. On the other hand, when

ryegrass is sown and simply harrowed in, it germinates, almost without exception, in five days.

M. Appelius's memoir contains, in the form of a table, the length of time necessary to germinate the seeds of many plants at a temperature of 55° to 54° in the sun, and 54° to 64° in the open air.

This table shows plainly, says the German author, that those seeds which are lighter than water require a longer time to germinate than those which are heavier.

A tolerably large number of seeds come up slowly, and even with difficulty; they are generally those which have a thick, tough skin. In this case it is a good plan to soak the sample in hot water, from 167 degrees to 185 degrees, for four and twenty hours, and not to sow it until after it has been prepared in this manner. Their germination may be assisted by notching—a more delicate operation than the first, because care must be taken not to injure the embryo. Unless one or the other of these methods is adopted, it will generally be one or two years before such seeds come up. The seeds of palm trees usually grow very well placed on damp sawdust, the germinating end downwards, and kept in a damp, warm atmosphere.

The spores of ferns and the seeds of orchids, which are very minute, come up rapidly, if they are scattered on pieces of peat placed in a pan with water.

For hardy plants M. Appelius recommends, as by far the best plan, to sow them in lines. In his opinion, the reason of the frequent failure of seeds in gardens is that they are sown in earth too dry and buried too deep. Besides, if care is not taken to press the earth lightly together before sowing the seed, heavy rains falling directly after will force some of the seed deeper in, and so occasion greater inequality in germination.

For perfectly hardy annuals, the best plan is to sow them late in the autumn, or, at least, very early in the spring; if the seeds are not in the ground before April you run the risk of seeing them flower very late and very badly.

Seedlings which are obliged to be raised in hotbeds or under frames, cause much disappointment, and consequently complaint of the quality of the samples. M. Appelius does not hesitate to say, in that case, the want of success arises more often from bad management than from the badness of the seeds. In his opinion it is a mistake to sow many kinds of flowers in high bottom-heat, such as stocks, asters, phlox, hearts eases, petunias, &c., which do far better in a very gentle hot-bed, and produce stronger plants, less likely to die off. On the other hand, it must not be forgotten that the dung with which a hot-bed is made, after it has given off its first heat, absorbs the moisture from the earth with which it is covered; that the surface of this earth under the frame generally slopes towards the south, and the greater part of the shower from the watering runs down this incline, the end of which is that the earth in which the seeds are embedded is often too dry, or, at least, it is so with that next to the back of the hot-bed. In this case, says M. Appelius, if you sow those seeds which germinate slowly and require constant damp, such as phlox and heartsease, at the bottom or in the front of the bed, and those which grow more readily at the top or back, the result will be good; but it will be quite the contrary if the reverse is done. Finally, the success of seedlings raised under frames depends principally upon the regulation of moisture. Another precaution, and one of the utmost importance in this case, is not to sow thick; a plant raised among a lot of crowded seedlings is very apt to die before it has made its fourth leaf. This seldom happens if, on the contrary, seeds are sown thin, and a little powdered charcoal mixed with the earth.

PREVENTION OF THE ATTACKS OF THE TURNIP FLY.

By steeping the seed in salt water, the attacks of the Turnip fly are partially or wholly prevented. Those who experimented last season mention it as a specific. In steeping the seed it is necessary to guard against injuring its vitality. Salt water made to a strength in which an egg will float is the prescription—the seed remaining about five minutes in the steep; the seed to be afterwards dried previous to sowing. Farmers, by experimenting with various steeps and dressings of the seed, may discover something practically useful. A solution of nitrate of soda, dissolved bones and Peruvian guano is very suitable for using for the steeping of seed. A vigorous growth of the plant in the first stages will follow such steeps. Care, however, must be taken not to impair or destroy the vitality of the seed.—*North British Agriculturist*, page 559, volume for 1859.

OBSERVATIONS ON SOUND AND UNSOUND POTATOES.

At a recent meeting of the Royal (English) Agricultural Society, Professor Way referred to some experiments he had made on sound and unsound potatoes. He found that if fresh slices of potatoes, in each of these conditions, were placed in separate portions (about a quarter

of a pint) of new milk, and kept warm for three or four hours, the milk in which the sound slice had been put would remain perfectly fresh and sweet; while that in which the unsound slice had been put would have become curdled. In many cases it was difficult to detect, by the eye, a sound potato from an unsound one; whereas this test at once decided the inherent qualities of each. Malt, he remarked, had the same effect on milk, and he attributed the effect of diseased potato on that fluid to the same cause, namely, to the presence of a peculiar fermentative principle.

CULTURE OF THE POTATO.

The Bath and West of England Agricultural Society offered, in 1858, a liberal prize for the best essay on the cultivation of the potato, which prize has been awarded during the past year to Dr. Lang, an English agriculturist, who has devoted much time to experimenting on this vegetable. The positions which this gentleman maintains are as follows:

He affirms that "the vigor of the set does not wear out by length of years," and that sound potatoes may be grown from diseased sets. He also denies the influence of soil in predisposing to disease, but that some manures have such an effect—farm-yard manure, for example, although it increases the yield. He recommends early planting. He prefers white to colored sorts, avoids nitrogenous manures, and employs lime and salt in the proportion of eight tons of lime with three hundred-weight of common salt to an acre. He likewise recommends cultivators to grow exclusively potatoes that ripen early, and, if the disease appears, to earth up the stalks. He recommends cutting the sets from smooth, middle-sized, fully ripe potatoes, that have been kept dry, planting in fresh earth, with a mixture of quicklime, and carefully avoiding rubbing off their first shoots.

ON THE ABSORPTION OF ARSENIC BY PLANTS.

That vegetables are killed by watering with an aqueous solution of arsenic was long ago shown by Marcet, Jager, Link &c., of Europe, and also by experiments made in this country. Still, mould will flourish in paste poisoned with arsenic, and some insects will feed upon animal matter impregnated with arsenic without apparent injury. Recent experiments, however, conducted by Dr. Edmund Davy, Professor of Agriculture and Agricultural Chemistry in the Royal Dublin Society, furnish us with some exceedingly interesting additional information respecting the action of arsenic upon plants. This gentleman, knowing that sulphuric acid containing arsenic was largely employed in making super-phosphate and other artificial manures, and that these must, therefore, contain variable quantities of that substance, conceived it probable that plants supplied with such manures might imbibe some arsenic, and in this way be rendered more or less unwholesome as articles of food. To ascertain, in the first instance, whether plants really take up arsenic when presented to their roots in the soil, Dr. Davy transplanted into a flower-pot three small plants of peas, and when they were established, he commenced watering them every second or third day with a saturated aqueous solution of arsenious acid; and *this treatment was continued for more than a week without its appearing to produce any injurious effects upon the plants.* At this period Dr. Davy was obliged to leave home for some months; on his return he found that these plants had grown up to their full size, had flowered and fruited. On chemical examination he detected arsenic in them, both in the herbage and seeds. Having thus learned "that arsenic might be taken up in considerable quantity by plants without destroying their vitality, or appearing even to interfere with their proper functions," Dr. Davy proceeded to ascertain whether arsenic, as it existed in different artificial manures, (such as the super-phosphate,) would in like manner be taken up by plants growing where these manures had been applied. He tried the experiments with cabbage-plants in a soil consisting of one part of super-phosphate to four of garden mould. When a plant had *grown healthily in this soil for three weeks* (where, the wonder is, that it should have grown at all, irrespective of the arsenic) he cut off its top, tested it for arsenic, and found "the most distinct indications of the presence of that substance." Finally, to ascertain if arsenic could be detected in crops grown with super-phosphate in the ordinary way and amount, he took turnips from fields in which this manure had been used, and obtained from them "the most unmistakable evidence of having been arseniated." The facts thus collected appear to Dr. Davy "to have some important bearings; for, though the quantity of arsenic which occurs in such manures is not large when compared with their other constituents, and the proportion of that substance which is thus added to the soil must be small, still plants may, during their growth, as in the case of alkaline and earthy salts, take up a considerable quantity of this substance, though its proportion in the soil may be very small. Further, as arsenic is well known to be an accumulative poison, by the continued use of vegetables containing even a minute proportion

of arsenic, that substance may collect in the system till its amount may exercise an injurious effect on the health of men and animals." Dr. Davy's paper is published in the London, Dublin and Edinburgh Philosophical Magazine, August, 1859, p. 108.—*Silliman's Journal.*

NEW CALIFORNIA GUM.

At a recent meeting of the Boston Society of Natural History, Dr. Hayes reported that a specimen of gum recently sent to that Society from California, and referred to him for examination, "proved to be pure Arabine, or the colorless constituent of gums, which is soluble in cold water and forms a clear gum solution without the character of emulsion. This gum is commercially valuable, the quality being fully equal to any imported."

JAPANESE VEGETABLE WAX.

At a meeting of the Boston Society of Natural History, April, 1859, Professor W. B. Rogers presented the result of an examination of the Japanese Vegetable Wax, which has recently become an article of commerce.

This substance has the whiteness and apparent purity of bleached beeswax, from which, however, it differs in various particulars, both as to mechanical and chemical relations.

At ordinary temperatures this vegetable wax is more brittle and less ductile than beeswax, and breaks with a smoother and more conchoidal fracture. Its specific gravity is slightly less, and its melting point, about 127°, is more than 20° lower than the temperature at which beeswax becomes liquid.

Like the latter substance, this vegetable wax is separable by alcohol into three fatty bodies, of which one is soluble in the liquid at ordinary temperatures, another only in hot alcohol, and a third is insoluble in it at any temperature. An experiment made to determine the proportion of these ingredients in the vegetable wax gave the following result, in round numbers, in 100 parts:

Soluble in cold alcohol (temperature 60°)	12 parts.
Soluble only in hot alcohol	55 "
Insoluble in alcohol	33 "

According to Brodie, beeswax similarly treated with alcohol yields only four or five per cent. of matter which is soluble in the liquid when cold, and twenty-two per cent. which dissolves in it when boiling, while the remainder, amounting to nearly three-fourths of the whole weight is entirely insoluble in this liquid. Of these three ingredients called, respectively, Cerolein, Cerotic acid, and Myricine, Brodie found the two former, viz: those soluble in cold and hot alcohol to have the character of fatty acids, while the third or Myricine proved to be a neutral fat, compounded of Palmitic acid and a fatty base. The three corresponding substances, isolated by alcohol from the vegetable wax, differ from these in some of their physical properties, and may, on closer examination, be found to consist wholly or in part of distinct and perhaps new fatty bodies.

The substance, separated by alcohol at the common temperature, is a soft, scarcely solid fat, which becomes entirely fluid at about 106°. With solution of litmus it exhibits quite a strong acid reaction.

The corresponding extract from beeswax, the Ceroline of Brodie, fuses at about 85° and shows a much feebler acidity. The ingredient dissolved from the vegetable wax by hot alcohol, and separating from the solution as it becomes cool, was found to have its fusing point at 134° and to become as liquid as oil at 136°. This substance dissolves readily in alcohol many degrees below boiling. The solution affords with litmus no trace of acid reaction. The corresponding educt of beeswax, the Cerotic acid, has a much higher melting point, is less soluble, and is distinctly acid.

The solid residuum from which hot alcohol had ceased to extract anything more, being dried and strongly compressed between folds of blotting paper, was found to adhere together very imperfectly, and to be much more brittle than the original wax. Its melting point is about 130°, and at 132° it is entirely liquid. The corresponding ingredient of beeswax, consisting chiefly of Myricine, melts at 147°.

It thus appears that the vegetable wax under consideration differs from beeswax, not only in the proportions of its ingredients as separable by alcohol, but in the physical character of these corresponding substances, the composition and chemical properties of which can only be determined by a thorough investigation. As regards its economical value, it saponifies readily, and when burned in the form of candles yields a strong clear light.

Dr. Jackson confirmed the above experiments of Professor Rogers, and stated that he had experimented on wax made by himself from the berries of this plant, *(Rhus succedanum).*

On boiling the berries in water the wax rises to the surface; it is a concrete volatile oil rather than a wax; it exists under the skin of the berry in abundant granules containing 14.6 per cent. of the wax. It is not likely that it would prove remunerative to bring so light and bulky a material to this country from Japan, for the purpose of extracting the wax here.

THE RICE PAPER-PLANT OF CHINA.

Recently, at the London Horticultural Society, a young stem of the Rice paper-plant *(Aralia papyrifera)*, cut in the island of Formosa by Mr. Fortune, who has lately returned from China, was exhibited by that gentleman, He stated that there is now no doubt that Formosa yields the greater part of the rice paper of commerce. This beautiful substance is largely consumed in the Canton and Fokien provinces. In the city of Foo-Chou-foo, every lady wears artificial flowers made from it. It is estimated that this place alone consumes about $30,000 worth of it annually. The cheapness of this article in the market shows that it must be very abundant in its place of growth. One hundred sheets, each about three inches square, can be bought for the small sum of three half pence. One almost wonders, Mr. F. remarked, that it is not more sought after by workers in artificial flowers. Rice paper is the pith of the plant, cut into thin sheets by the Chinese.

THE CHINESE GRASS-CLOTH PLANT.

The following extract from the report of Mr. Nathaniel Wilson, curator of the botanical garden at Bath, Jamaica, describes the successful introduction into that island of the China grass-cloth plant, the Rheea of Assam, and the propriety of turning to profitable account their numerous indigenous fibrous-yielding plants, which are at present quite neglected:— "I have now the happiness of recording my entire success in the cultivation of the Chinese grass-cloth plant, *(Boehmeria nivea,)* introduced in 1854, and a more valuable introduction could not have been made. I find the plant thrives here with a luxuriance equal to any of our native plants, and probably with more vigor than it does in its native clime. This plant (as it is now well known) produces the best fibre for textile purposes with which we are acquainted, and, according to undoubted authority, is worth, in the London market, from £80 to £120 per ton; which is surely sufficient to render the plant an object worthy all the attention we can bestow on it, if new staples for general and profitable cultivation be desirable. I have no hesitation in saying that, by its spontaneous and luxuriant growth, a more desirable and appropriate plant for tropical culture has never before been submitted to the notice of the public."

GRASS OF THE BRAZILIAN PAMPAS.

"One of the most interesting plants now in flower at Turnham Green gardens is the Pampas grass of Brazil, *(Gynerium argentum.)* This plant has twelve flower stems, each some eight feet long, about the thickness of the thumb, and supported by an erect panicle of inflorescence at least eighteen inches in length, which, beneath the bright sunshine, looks a beautiful, light-colored feather, spangled with silver; the panicle is in the form of the beautiful *Arundo phragmites.* The leaves, which are some seven or eight feet long, with a hard, flinty skin, grow in tussocks, which, in situations at all favorable, soon acquire a large size. When in flower, certainly few plants are more striking or magnificent in appearance than this gigantic grass, which, being perfectly hardy, will be found to be a great acquisition to ornamental grounds."—*London Gardner's Chronicle.*

AUSTRALIAN NETTLES.

The shining nettle of Moreton bay is a true nettle, but a large tree, with bright, glossy leaves, something resembling mulberry leaves in shape, and bunches of white flowers, something like small bunches of white lilac flowers, but pendant. The most remarkable nettle, however, of this country is the *Urtica gigas*, or rough nettle tree. This tree has a large leaf, something like a sunflower leaf, hirsute beneath, and every bristle has a most painful sting. Some gentlemen, who had been in Illawara, collecting specimens of trees for the Paris exhibition, told me they had measured one of these wonderful trees, which was 32 feet round, and, I think, 140 high. Such is the potency of this virus of this tree that horses that are driven rapidly through the forests where they abound, if they come in contact with their leaves, die in convulsions. I have seen a statement of the actual death of his horse by a traveller through these parts, and one of the gentlemen of the Exhibition committee told me that, as they were riding in the Illawara forest, a young man who had lately arrived, and was

ignorant of the nature of the tree, breaking off a twig as he rode along, had his hand instantly paralyzed by it. His fingers were pressed firmly together, and were as rigid as stone. Fortunately a stockman, who was near, observing it, came up and said, "I see what is amiss, and will soon set all right." He gathered a species of arum, which grew near—for nature had planted the bane and the antidote together in the low grounds—and rubbing the hand with it, it very soon relaxed and resumed its natural place. This is precisely the process used by the children in England; when nettled they rub the place with a bruised dock-leaf, saying all the while, "Nettle go out; dock go in."—*Howitt's Land, Labor and Gold.*

OBSERVATIONS ON ENGLISH HUSBANDRY.

BY HON. HENRY F. FRENCH, EXETER, N. H.

I.—GENERAL SYSTEM OF HUSBANDRY.

PRODUCT PER ACRE DOUBLE THAT OF THE UNITED STATES.—WHY?—EFFECT OF THE ARISTOCRATIC ELEMENT ON PRODUCTIVENESS.—PRIMOGENITURE, LARGE ESTATES, LANDLORDS, FARMERS OR TENANTS, AND LABORERS.—EDUCATION, LOW WAGES, DIVISION OF LABOR, SKETCH OF AN ENGLISH FARM, FOUR COURSE SYSTEM, CAPITAL EMPLOYED, LEASES, COMPARISON OF RESULTS.

The English farmer usually is not the owner of his farm, but pays an annual rent for it (taking an average for all the cultivated lands, including grass) of nearly seven dollars an acre. In addition to this rent, he pays the rates or taxes, which cannot be exactly stated in the average, but which usually amount to about half the rent. We may fairly set down ten dollars an acre as what the English farmer pays each year for the use of his land—not merely for what he ploughs and plants, but for the whole extent in tillage, mowing and pasture.

This payment he usually meets semi-annually in money, and, supporting himself and family liberally, adds something to his capital. His whole time, attention and capital are devoted to his farm, and he has no other source of income. The American farmer of the wheat-growing States—for our comparison does not extend to the South—usually owns the land he tills, which he has purchased often at less than the annual rent of an English farm, and his rates and taxes are merely nominal; yet the impression generally prevails that agriculture in America is an unprofitable business, and requires to be helped out by some collateral employment.

The English farmer, too, cultivates old fields, which have felt the pressure of the plough for centuries, while the American farmer opens a virgin soil, requiring, or at least receiving in the new States, no manure for many successive years.

Again: comparing particular products, we find the average crop of wheat on all the lands in wheat in the United States, by the census of 1850, *to be nine and one-eighth bushels per acre*, while the average crop of all the wheat lands in England is estimated at twenty-eight bushels to the acre! and the average product in all Scotland, in the year 1856, is accurately ascertained to have been twenty-nine and a half bushels per acre. The averages in the great wheat-growing States are less than one-half those of England—New York, Ohio, and Indiana yielding but twelve bushels, Illinois and Missouri but eleven bushels and Iowa but fourteen bushels to the acre. For our consolation it may be added that official returns show the very low average of eight bushels of wheat per acre for Lower Canada, and only twelve for the justly-boasted garden of the province, Western Canada.

What is the secret of English husbandry by which these results are obtained? How can the English farmer sustain the heavy burdens of rent and taxes and make a profit beyond his support; and how can he at the same time steadily increase the fertility of his soil while annually securing from it crops so valuable? To answer these questions fairly and intelligently was a principal object of the writer's visit to England and of careful investigation there, and is now a chief subject of inquiry. Does the superior productiveness of English agriculture result from natural advantages of soil and climate; from a structure of society better adapted than our own to develop her resources; or from a more intelligent application of science and labor to the culture of the earth? and can we, without a sacrifice beyond the

advantage gained so far conform to her practice as to materially increase the products of our fields?

The small average of our crops, however, is not the most discouraging feature of our agriculture. The depreciation of our soil, and the decrease of the average product per acre of our crops, is attracting the attention of observing men both at home and abroad.

Liebig (in his Modern Agriculture) refers to this, which he significantly terms the "Spoliation System," thus:—"The deplorable effects of the spoliation system of farming are nowhere more strikingly evident than in America, where the early colonists found tracts of land which, for many years, by simply ploughing and sowing, yielded a succession of abundant wheat and tobacco harvests. We all know what has become of those fields. In less than two generations, although originally so teeming with fertility, they were turned into deserts, and in many districts brought to a state of such absolute exhaustion, that even now, after having lain fallow more than a hundred years, they will not yield a remunerative crop of a cereal plant." Again, he says:—"The American farmer despoils his field without the least attempt at method in the process. When it ceases to yield him sufficiently abundant crops he simply quits it, and with his seed and plants, betakes himself to a fresh field; for there is plenty of good land to be had in America."

That these are no slanders of foreign writers merely, we may refer to an article in the Patent Office Report of 1852, which fully supports this view.

"Several years ago," says the Secretary of the Ohio Board of Agriculture, "I became aware of the fact that wheat, the staple crop of Ohio, was annually diminishing in its yield per acre, that in less than fifty years the average product was reduced from thirty to less than fifteen bushels per acre. I also learned that in Great Britain the yield had increased from sixteen to thirty-six bushels per acre during the same period."

In the old State of Massachusetts we have it stated by the Board of Agriculture that in ten years, ending in 1850, "although the tillage land had increased more than 40,000 acres," there had been no increase of grain crops, but an absolute depreciation of 600,000 bushels, and with an increase of 100,000 acres of pasturage there had been scarcely any increase of neat cattle, and a decrease of 160,000 sheep and 17,000 swine.

Surely it is time, with such facts before us, that we should endeavor to study the theories and practice of any nation which is making healthy progress in agriculture.

The practice of husbandry in England cannot be well understood without an appreciation of the structure of society there. Indeed, we shall be struck, upon a view even of the broad outlines of the classes with which the people of that country are divided by the mere force of the fundamental principles of the government, with the absolute control of the aristocratic element over the private relations of life and even the productive capacity of the soil. We shall see that an aristocracy of wealth and education and political power implies poverty and ignorance and servility somewhere; but we shall not find, it is believed, that ignorance and degradation in the laborer, though they chance to be coexistent with good husbandry, are at all essential to it, even in England.

On the contrary, it is the opinion of the best minds in that kingdom that the education of the laboring classes would promote the best interests of all, and the Prince Consort himself is an active and powerful advocate for the adoption of measures for the elevation of the English laborer from his ignorance and consequent degradation.

A careful consideration of the points of difference between the principles of government and structure of society in England and America will enable us to determine how much of the striking difference in the results of agriculture in the two countries is due to what may be termed political causes, and how much is due to the difference in agricultural science and skill.

In many points the resemblance between the two countries is very strong. The English Common Law is the basis of the jurisprudence of nearly every American State. If we enter the courts of Westminster Hall, we see the trials at law dragging their slow length along with a tedious respect for forms and precedents quite familiar to those conversant with proceedings in New England courts. If the grave judges of England were divested of their white wigs, which, formed of the hair of horses' tails, is thought for some reason more venerable than the natural growth of the human head, we should hardly realize, when in their presence, that we were not in a court of Massachusetts or the Supreme Court at Washington. In both countries, human life, liberty and rights, are sacredly protected by just and equal laws, publicly and ably administered.

The literature of both countries is the same. Within the sacred walls of Westminster Abbey we behold statues and monuments in memory of Chaucer, Milton, Shakspeare, Wordsworth and Addison, and we feel that these names, familiar as household words, are sacred as those of the fathers of American literature.

In blood we are substantially one, for we trace back to the "mother country," if, indeed, we value our ancestry enough to take that trouble, and find our origin mostly on English soil; and we are startled almost at the familiar names that in the old towns of England

catch the eye upon the doors and sign boards as we walk the streets. And lastly, we are alike, in general, in our religious faith; for, diverse as are the forms of worship used in both countries, the same leading and predominant religious sentiments prevail in both.

Finding no essential differences in the principles of law or its administration, nor in the literature, nor blood nor religious faith of the two nations, let us glance a moment at the political structure of society in England, and observe its effect upon the tenure and management of property and the consequent productiveness of the soil.

The United Kingdom of Great Britain and Ireland is governed by its King or Queen, and two houses of Parliament, known as the Three Estates of the Realm.

At the head of the government is the Sovereign, exercising the same power whether King or Queen. This office is hereditary, passing on the decease to the next heir, males in equal degree of kindred being preferred to females. Thus, any son of the present Queen would inherit the throne to the exclusion of her eldest daughter, but any daughter would stand in the order of succession before an uncle, a nephew or a male cousin. The crown can be worn only by a Protestant, and the King or Queen or heir apparent, marrying a Catholic, forfeits from that moment all title to wear it.

The person of the sovereign is sacred; and she is said to be above the law. It is a maxim that she can do no wrong—that is to say, that he is not responsible for any act, because there is no tribunal competent to call her to account.

Her theoretical powers, or prerogatives, are very great. She has the power to pardon criminals, she is the theoretical fountain of all rank and honor. From her spring all titles of nobility, all military and civil rewards, such as orders of knighthood, crosses, stars and medals, and all commissions in the army and navy. She has the power of proroguing Parliament, and of dissolving it and convoking a new one in its place. She is said to be the supreme head of the State, the Church, the Army, and the Navy; she has the power of sending and receiving embassadors, of declaring war and making peace, of arranging treaties, and of coining money and of refusing her assent to acts of Parliament, and thus preventing their operations.

Formidable as this enumeration of power might seem to render the sovereign, we do not recognize in the political or civil rights, duties or dignity of this first Estate of the Realm, the source of the distinctive ranks into which society in England is divided. With the strict accountability to which her ministers and officers are held for every act, and the power of Parliament to compel a change of her cabinet whenever its measures are not acceptable, the sovereignty of Great Britain is a power scarcely so actual and positive as that of our own President; and with an elective monarchy, or an executive officer of any other name or title, the British government might perhaps be administered without other substantial change, could the nation substitute in place of their personal loyalty to her most gracious Majesty, and their pride in the royal family, a similar sentiment of loyalty and pride in the government as an abstraction. When, however, we consider that the annual allowance to the Queen for the support of her household and the dignity of her crown is nearly two million of dollars, besides annual grants to his Royal Highness, the Prince Consort and various other members of the royal family, we perceive that the tax-payers of Great Britain are paying liberally either for a sentiment or a reality in the sovereignty, from the support of which our citizens are almost wholly excused.

The House of Lords or Peers, which is the upper house of Parliament, constitutes the second Estate of the Realm. Before their union with England, Ireland and Scotland had each a parliament, with a House of Lords of its own. Now, however, there is but one house, and only a certain number of peers selected from the nobility of the sister countries have seats in it. Power is rapidly passing from Scotland and Ireland, and they are becoming absorbed in English authority. Peers of Scotland are no longer created. For every three Irish peerages that become extinct, the Queen may create one new one, while there is no limit to the number of British peers that she may make. The upper house is at present composed of 28 peers of Ireland elected for life, 16 peers of Scotland elected for each Parliament, 363 peers of England, and 30 spiritual peers. The titles of the peers of England are hereditary, and they hold in themselves and families a large proportion of the wealth, and especially of the land of the nation, and constitute its aristocracy. The House of Commons consists of representatives elected by the people, and corresponds very nearly to our own House of Representatives. In England, again, property does not descend equally to the children of the intestate, as it does in most of our States, but the real estate with the title descends to the eldest son. Thus large estates, instead of being distributed, as in this country, among many at the death of the owner, are kept together. These two features of a hereditary nobility and the rights of primogeniture distinguish the British government from our own. They are the seals of security for an aristocracy of rank and power and wealth, which, without them, could not be maintained; and when looking further we find that with these advantages are united an education and intellectual training unsurpassed in the world by any body of political men, and far above the attainment of other citizens of their own

country, we perceive how it may be possible for such an aristocracy to exercise a controlling influence in all affairs, both public and private.

Wealth, and especially land, being thus sacred in the hands of a few individuals, the next relation we have to consider arises as a necessity, namely, that of LANDLORD AND TENANT.

The large owners of land, having in charge the political affairs of the nation, and having little time for the details of agriculture in person, employ agents and bailiffs to aid them, and their estates are principally divided into farms of convenient size, and leased, for a stipulated annual rent, to tenants, who are called FARMERS; so that most of the farmers of England are not owners, but tenants of their lands, either from year to year or for a term of years.

It is found, again, more convenient for the large proprietor to lease his lands in large tracts, usually of from 100 to 1,000 acres, so that the tenant farmer is unable to perform the necessary labor of cultivating it in person, and therefore is obliged to avail himself of the service of still another and lower class, that of the LABORER.

Thus, naturally, if not inevitably, we find the people of England, by the controlling force of the aristocratic principle of their constitution, divided into three distinct classes: the nobility, the middle class and the laborer, or, as related to agriculture, the LANDOWNER or LANDLORD, the FARMER OR TENANT and the LABORER.

The estates of some of the English nobility to our republican ideas seem truly enormous. Incomes of twenty, forty, a hundred thousand pounds sterling are by no means uncommon, and occasional instances are named of annual incomes as large as two or three hundred thousand pounds. Mr. Colman speaks of a farmer in Northumberland who paid an annual rent of thirty-five thousand dollars, and of a nobleman who has under his immediate supervision twelve thousand acres of land in a course of systematic cultivation. Mr. Tucker, who has recently returned from England, speaks of a conversation which he had with a gentleman in quite a retired part of the country, who said that within five miles he could point to three residents on neighboring estates, each of whom was considered to possess in his own right property to the amount of from four to six millions of dollars. A recent writer from England states that the amount of "annual tribute paid as rent" by the farmers of England to the landed aristocracy is $300,000,000!

Looking still further at the operation of the same causes, let us notice the condition of those various classes as to EDUCATION. So sharp and real are these distinctions into classes that no equality in social life is found to be convenient. The nobility and gentry, elevated in taste and intellect, as well as in rank and power, by generations of culture, trained, both mentally and physically, so thoroughly and wisely that they have become, perhaps, as a class, superior to any equal number in any existing class in the world, find their society exclusively with each other. The farmer and the tradesman neither claim nor receive a position of social equality with them. They do not visit in the same circles. They do not sit at the same table. Everywhere, on all occasions, public and private, the privileged class quietly and without question, occupies its position of superiority.

It is the same in the schools and colleges as elsewhere. The sons of the nobility do not attend the same schools with those of any lower class. A forcible illustration of this fact is found in the attempt to establish an agricultural college at Cirencester, originally designed for the education of the sons of small farmers, but which seems to have failed in that object.

"Formerly," says Dr. Hitchcock, in his report to the Legislature of Massachusetts, "the school was opened for the sons of small farmers, but could not find support on that plan, and it was found that if these attended, the wealthier classes would not send their sons. The price, accordingly, has been raised, and none but the sons of gentlemen, such as clergymen and wealthy laymen, now attend. None of the nobility send their children, although many give their money for its support."

Here we have the "small farmers," the "gentlemen," and the "nobility," so distinct that their children cannot attend the same agricultural college. But neither of these three classes includes the laborer, who is, in fact, so far below them all, in point of privilege and position, that until recently hardly an effort has been made for his education. We give the high authority of his Royal Highness Prince Albert to show how utterly neglected and degraded must be the condition of the British laboring classes. The statement was made "at the inauguration of a Conference of the supporters of the education of the working classes," in June, 1857, as reported in the newspapers of the day.

He said that the whole number of children in England and Wales was estimated at 4,908,006, and that of these only 2,861,848 received any instruction whatever, and that of these two millions of children attending school, only about 600,000 are above the age of nine years; so that only about two-fifths of the children of England and Wales between five and fifteen years of age, and only about one-eighth of those between nine and fifteen, attend school at all.

In discussing the subject of education in England, we prefer to cite English writers, rather than to depend upon any impressions that might be found in a short visit to the rural dis-

tricts of that country. "The British laborer," says a writer, who is thus quoted in the Cyclopedia of Agriculture, "is the best *living tool* in the world. But here all his knowledge and intelligence ends. Beyond his field or his workshop he generally knows nothing. There is no amount of ignorance or error of which he is not capable. He knows nothing of the face of this globe, nothing of the history or constitution of his country. If he is old enough to remember George IV, he may possibly be shrewd enough to conclude that there was also a George I, but beyond that he knows nothing; and, in general, if he were informed by a gentleman that George I was established in this kingdom by Cæsar, or Alexander, or Abraham, he would swallow it without the smallest hesitation, just as he would any other absurdity in history or science. In truth, so far as regards all these things, he is an utter barbarian."

The laborers do not live in the houses of their employers, but in small and usually poor cottages, often at a distance of two or three miles from their work, walking to and from their labor daily. In their minute division of labor, there is little variety or occasion for the exercise of judgment. A ploughman always ploughs, a shepherd is always a shepherd. There is before them little to hope for. Their daily pittance, amounting to two or three dollars per week, must in some way be made to support the family, with what the wife and children can earn. There is no idea of progress among them. The expectation of ever owning an acre of land is as impossible to them as to occupy a throne, and the chance of occupying the almshouse is far greater to most of them than the chance of ever owning property to the value of one hundred dollars. The absence of hope of bettering his condition, regular daily monotonous toil, the want of variety in this labor and life, and often the want of suitable and abundant food, give the English laborer a dull and heavy expression, and his acknowledged dependence and inferiority renders his manner not merely deferential but servile. In conversing with many laborers, usually of those receiving the highest wages, we found no one who did not express the difficulty of making both ends of the year meet, even in prosperous times, while the idea of a competency for old age seemed entirely out of the question.

We prefer to give British authority when illustrating the unfavorable views of English life, and therefore quote from Mr. Caird as to the condition of the laborers of South Wiltshire: "The command of wages is altogether under the control of the large farmers, some of whom employ the whole labor of the parish. Six shillings a week was the amount given for ordinary laborers by the most extensive farmer in South Wilts, who holds nearly 5,000 acres of land, a great part of which is his own property; seven shillings, however, is the more common rate, out of which the laborer has to pay one shilling a week for the rent of his cottage. Where a man's family can earn something at out-door work, this pittance is eked out a little, but in cases where there is a numerous young family, great pinching must be endured. We were curious to know how the money was economized, and heard from a laborer the following account of a day's diet: After doing up his horses, he takes breakfast, which is made of flour with a little butter, and water from the tea-kettle poured over it. He takes with him to the field a piece of bread and (if he has not a young family, and can afford it) cheese to eat at mid-day. He returns home in the afternoon to a few potatoes, and possibly a little bacon, though only those who are better off can afford this. The supper very commonly consists of bread and water.

"The appearance of the laborers showed, as might be expected from such meager diet, a want of that vigor and elasticity which mark the well-fed ploughman of the northern and midland counties. Beer is given by the master in hay-time and harvest. Some farmers allow ground for planting potatoes to their laborers and carry home their fuel."

A great obstacle in the way of any attempts to educate the laboring classes is their extreme poverty, which compels them to exact labor from even their small children. In personal interviews with teachers of schools supported partly by government, the writer was assured that it was impossible to establish or maintain system, because of the irregular attendance of the scholars; that frequently by an offer of a few pence a day by some proprietor or contractor for light labor, nearly the whole school would disappear at once, and be found picking small stones or weeding the crops in some neighboring field; and no more melancholy sight meets the eye of an American in England than a band of these little laborers of from six to twelve years of age, toiling together under the charge of a taskmaster.

If schools were established throughout England, the laborers are too poor to send their children, and so they go on from generation to generation in ignorance and degradation almost beyond hope.

Let no one confound for a moment the English farmer with the laborer, for the distinction is fully as marked between the two latter, as between the nobleman and the farmer, and, indeed, more so. The nobleman sometimes, as an act of condescension, invites his tenant-farmer to his table, and not unfrequently the young farmers, who raise and train hunting horses for the market, are invited to join the chase and ride with the gentry after the

hounds. Indeed, there is a sympathy and attachment apparently between these classes. Most of the agents and bailiffs who manage the estates of the nobility are sons of farmers, and farmers are men often of large capital and good education. But the laborer is far below the farmer. He is not invited to his table; he is not treated as an equal, but as a servant. Without property, without education, without a vote or any voice in public affairs, he is, in truth, and literally, a LABORER, and nothing more.

Having thus an aristocracy of rank, wealth, and education, a middle class of intelligent, active, business-like, and, as to their vocation, well-educated farmers, and a lower class of laborers born on the estate where they labor, and with too little knowledge of the world to conceive of the possibility of leaving their birth place, and too ignorant to find anything but failure should they attempt to change their condition, it must result as an inevitable consequence that the wages of their labor is at the lowest rate consistent with the good health and physical ability of the laborer.

THE LOW RATE OF WAGES in England is an important element in a comparison of English and American husbandry. We may admire the clean cultivation, (the result of much ploughing and cultivating,) of hoeing and hand-weeding of their wheat crops, but whether it is possible for us to follow their example depends mainly on the comparative cost of labor in producing the crop, and its price in the market.

Mr. Caird, in his published table showing the average weekly wages of labor in the different counties in England in 1801, gives the lowest in Gloucester and South Wilts at 7*s.*, ($1 75,) and the highest in the West Riding of Yorkshire at just double that rate. The average weekly wages of a man's labor in all the counties is given at 9*s.* 6*d.*, (about $2 57,) or a little less than forty cents per pay, and the laborer out of this poor pittance provides his own support and pays his rent. It is not easy to estimate the price of labor throughout the United States, but it is safe to say that it is something more than double this amount.

And here we touch one of the great secrets of agricultural success in England. Her farmers are able to bear the burdens of heavy rents and taxes, and to live comfortably, and even accumulate property, because, to express the truth plainly, the laborers, who constitute the large majority of the people, do not receive a fair compensation for their labor, and because they and their families are kept in ignorance, poverty, and degradation. Even women and small children are compelled to labor in the fields for a paltry compensation, that the farmer may produce his crops at a profit sufficient to enable him to pay his enormous rents, and that the land owner may devote his time to education and the management of political affairs, and the public treasury be supplied with means to support the enormous expenses of a royal family and of a magnificent government, and pay the interest on an immense national debt. Were the English farmer compelled to pay American prices for the labor on his farm for a term of five years he would be entirely ruined—utterly unable to pay his rent, and national bankruptcy would ensue.

But, on the other hand, if American farmers were required to pay the rents and charges which English farmers annually meet, it is doubtful whether, even with English prices of labor, they would be able to find a profit in their operations. Certainly they would not under their present wasteful use of land and their exhaustive methods of culture.

It is but justice, however, to the occupants of our new and cheap lands that we should bear in mind constantly, when making these comparisons, the difference in the value of land and labor in the Old and the New World, and the impossibility, too, of obtaining at any price the labor necessary to the careful and thorough culture of his land. Here the Western pioneer buys his land of the government at $1 25 per acre, and enters upon some hundreds of acres, single handed, to produce his crops. Often his money is borrowed to pay for his land, which is mortgaged for the price. It is not an open question for him whether his farm shall be so cultivated as to preserve its fertility, or what investment of capital would be most judicious; but the question is, How can I get bread for my children, and how can I make my land pay for itself, so that my creditor shall not take it from me? His only policy is to produce the greatest value of crops for the market with the least labor, just to scare the wolf from the door, and at some more convenient season discuss the nice points of husbandry. In many parts of our country, however, there exists capital enough, and land bears a price nearly as high as in some counties in England, and the same inducements are found for careful and systematic cultivation.

THE EFFECTS OF LARGE ESTATES upon agriculture deserves our careful consideration. The large proprietor usually reserves extensive domains for his own cultivation and pleasure, and his steward gives personal attention to that part of the estate, and has charge of the leasing and management of the several forms into which the rest is divided.

Written leases are given in some districts, but in the greater part of England the farmer holds under a verbal tenure, governed by the usages that are understood to prevail. In either case the tenants are under many restrictions as to the management of their farms, the kinds of crops and their rotation being carefully fixed. Among these restrictions are usually

found provisions that permanent grass and pasture shall not be converted into tillage, and that two white crops, as of wheat and barley, shall not succeed each other. From the uniformity of these conditions over large estates naturally grows up a systematic method of cultivation, and an exact knowledge of processes and results which nowhere prevails in America. The noblemen who have large estates seem to consider their nobility as based upon land, and are always interested in the introduction of improved stock, implements, and processes of husbandry. Their stewards are men of education and ability. The farmers, too, are intelligent and energetic, so that, in fact, the highest talent and the best practical ability of the country are brought to bear upon agriculture.

Capital, too, is abundant in England, and seeks investment at what in America are deemed low rates of interest. It is not a question there how little capital can be made to conduct the farm, but how much can permanently be invested so as to return a fair interest. By the concentration of capital and of land in the same hands, extensive operations are more readily conducted. Especially in the draining and reclaiming of wet lands, the control of large tracts and of large capital is essential to any successful result. Where land is subdivided, as in New England, owners are not ready to unite in expensive improvements of a permanent character, and single owners, for want of outfalls through adjacent lands, find drainage impossible. There is, too, a want of confidence in farmers themselves in their own business. They seem unwilling to employ what capital they possess, and often invest it in bank or railway stock, rather than in the improvement of their farms.

This arises, in a great measure, from a want of a clear perception of the true sources of profit. They seem to have the impression that the land itself is the only capital necessary, and that to be employed by their personal labor alone.

The division of labor on the farm in England is another advantage of large estates. Most farm labor there is performed by piece-work, the laborer receiving so much an acre for ploughing, for hoeing, or so much a rod for ditching. The laborer being attached as it were to a single estate or farm, finds constant employment in one occupation. The ploughman, as we have said, is always a ploughman; and there being in the southern and middle counties little frost, he ploughs nearly every day in the year.

By this means the workman acquires a skill and manual dexterity not otherwise attainable. An ignorant laborer in England who has little more education than the beasts which he drives, turns a better furrow than any man with us who, however enlightened by education, has his hand upon the plough but a few days in the year. In many parts of England the wheat drilled seven or eight inches apart is horse-hoed by an implement made exactly to match the drill, and passed between the drills drawn by a horse, ten or twelve drills being hoed at once.

The same process of hoeing turnips and mangolds, four or five rows at a time, is commonly practiced. In all these operations we witness a skill on the part of the laborer rarely equalled in our own country.

As the effect of the various causes to which we have alluded, we find in England a more thorough and systematic culture, and results altogether more uniform and reliable, than in America. The English farmer can give you at once an accurate statement of the cost of every operation on his farm, and so of the cost per acre of every crop. He estimates with almost perfect accuracy the number of bushels per acre which his field will yield, and calculates with great exactness the amount of manure profitable to be applied for the expected crop or rotation.

"We can produce readily thirty-two bushels of wheat to the acre," said a Lincolnshire farmer, "but we consider twenty-eight bushels a more profitable crop, as the other four bushels cost us more than their value in extra manure and culture."

Perhaps no method can be adopted by which to convey to the reader a clear idea of an English farm, and the mode of conducting its operations, than by giving from a note-book, in which were recorded on the farm itself the personal observations of the writer, verified by familiar conversations with the tenant himself, a sketch of a Lincolnshire farm. A picture of such a farm is a fair representation of English farming and farm life; for although in particular districts some peculiar crops are cultivated, yet what will be described as the "four-shift" of "four-field" system prevails over the greater part of the kingdom, and Lincolnshire is perhaps a fair average county.

Of the English farmer himself we may, from personal intercourse, venture to say, in general, that he is a substantial, self-reliant, independent man, well educated for his business. He is familiar by early practice with the manual processes of labor. He can hold the plough as well as his ploughman, and wield the hoe to show his laborers the proper stroke; and he maintains their respect because he excels them in almost everything. Yet he does not labor daily with his hands, not because he despises labor, but because he is fully occupied with the direction of affairs. It will be manifest, when we see the amount of capital employed, the value of the crops sold, the amount of manures and the number of animals

purchased, that the trading department of his business requires almost a mercantile education.

In his family an English farmer upon a large farm lives in much the style of the wealthiest New England land owners. The same fact is observable there as here, that the wife and daughters, by some means, acquire a more finished education than the men, and conduct their household affairs with a grace and dignity which is accounted for partly by the fact that many of them have been sent from home to be educated, and partly from a natural susceptibility by the sex of a nicer polish than ours. With servants enough to relieve her of the drudgery of hard labor, the farmer's wife gives careful personal attention to her household, and has leisure to entertain handsomely the friends and guests of the family.

The farm which we have in mind, as a representative English farm, contains one thousand acres of land, partly upon Lincoln Heath, which is a light soil, and partly upon clay. Lincoln Heath, a century ago, was an open common, trackless and dreary, and so dangerous to travellers that, in 1751, a land light-house was erected of stone as a guide to them by night, which is still standing.

Arthur Young, in 1780, expresses astonishment that farmers could pay $2 50 an acre rent for some of those lands, which a few years before had yielded nothing. For these lands the rent is doubled since then; and at Blankney several thousand acres were let as rabbit warrens in his time at fifty to eighty-seven cents an acre, for which five dollars is now received. The average product of those lands now is nearly thirty bushels of wheat per acre. The heath requires no artificial drainage. It is a thin soil, with limestone underlying it, often only a foot or two below the surface, in the form of a loose stone, growing harder below. The clay soil is heavy, and is nearly all underdrained with tiles. The rent of the farm is $5,500 a year, or $5 50 per acre. The tenant holds by no written lease, but by a sort of traditionary custom. He feels as secure, and seems, in fact, as permanently fixed, as if he owned the fee. The landlord has the power to turn him away at the end of any year, but there are certain "tenant-rights," which are rendered sacred by custom, which give him protection. To those we shall have occasion to advert when we speak of the capital necessary for a tenant to employ on such a farm.

The crops grown upon the farm are usually two hundred and fifty acres of wheat, two hundred and fifty acres of barley, two hundred acres of turnips, and the balance in permanent grass, and seeds, as the crop from the last year's sowing of grass seed is termed; small patches for gardens, for beans for the horses, and for mangolds, are reserved, but these are exceptional, and hardly belong to the regular system.

We will just run through the four-field system on light lands, and commence with the field in turnips, mostly Swedes. These are consumed upon the land by sheep, confined in hurdles, which are movable fences, usually of wood. The object is to keep the sheep upon the land long enough to manure it for the succeeding crops. The sheep are kept in flocks of one or two hundred in the hurdles, and moved along when they have performed their office of fertilizing. The turnips are usually cut with a machine, and fed to the sheep in troughs. A quantity of oil cake (linseed) is supplied, and the usual estimate is, that an acre of turnips, with two hundred and fifty or five hundred pounds of cake, will keep seven sheep twenty weeks, or one hundred and forty sheep one week—equal to nine hundred and eighty sheep one day. The sheep are fed in this way, without shelter, through most of the winter. Mr. Mechi's estimate is that fifteen hundred sheep folded on an acre of land for twenty-four hours, or one hundred sheep for fifteen days, would manure the land sufficiently to carry it through a four years' rotation. Mr. Mechi is, however, practicing a higher kind of "high farming" than is thought by many to be profitable.

The second year is barley. For this crop the land is ploughed very shoal, only about two inches, with a wheel plough, so as to keep the manure at the surface, and then harrowed and rolled. The seed is then drilled, which should be done before the 6th of April, three and a half bushels to the acre, across the furrow. At the same time fourteen pounds of red or white clover and a half-peck to a peck of ryegrass (not common ryegrass, which cannot be drilled) is sown across the barley, three inches apart. The barley is twice carefully weeded by hand. It cannot be horse-hoed, because of the "seeds." About thirty-six bushels of barley to the acre is a fair crop on this land. The value of barley depends on its malting properties, and varies thirty or forty cents per bushel sometimes in quality, though of the same weight, depending on the soil and the success of securing it without wet.

Barley is usually cut about the first week in September, and the young "seeds" are then fed by sheep and lambs till the 14th of October, when the sheep are put upon the turnips, and the seeds allowed to gain strength.

The third year is "seeds" or grass. The field is stocked with four ewes and four lambs per acre, April 6, when the turnips are usually gone. Yearling beasts are turned in also, to keep down the ryegrass. Six "hogs" or "hoggets," the name for yearling sheep, instead of the ewes and lambs, may be put over most of the field, reserving say a quarter to

mow for the horses and cattle at the homestead. The lambs are usually put upon this quarter after mowing, to consume the fresh crop. The sheep are thus kept on the whole till the wheat and barley are cut, and then turned on to the stubble. It is an object to leave a good growth of "seeds" to plough in for the next year's crop. The seeds are then manured with six or eight tons of farm-yard manure, and more if it can be spared. Frequently the manure is spread and remains upon the surface several weeks before it is ploughed in, exposed to the action of the atmosphere. This is one of the disputed points among agriculturists in America. The general notion has been, until quite recently, that such exposure of manure subjects it to great loss by the escape of ammonia and other volatile elements, and farmers have hastened to cover it by the plough as soon as possible. Of late a different theory and practice have made progress, and it has been contended that this loss has been greatly overrated. In Lincolnshire and many other parts of England the farmers prefer to spread even green manure several weeks on the surface. "Theory," say they, "seems against us, for there must be some loss, and it is difficult to say how there can be any gain, but we KNOW, from uniform experience for years, that we get better wheat crops by this practice." Upon our suggestion to a very intelligent farmer that the powerful odor from his manure thus spread *indicated* great waste, he replied: "I admit there may be some loss, but I think less than is usually supposed. What we smell is partly sulphuretted hydrogen, which is of no value, and partly ammonia, which is of great value to agriculture. The quantity of ammonia thus lost, however, is not great, and might be purchased at any shop for a few shillings." The land is then ploughed, with two horses, from three to six inches deep, according to the soil—the best land deepest. A "compresser," a sort of serrated roller, follows, to keep down the grass and make the land solid. The land is then harrowed and sown with wheat from early in October to the 20th of November—the nearer the 20th of October the better. The seed is drilled about eight inches apart, ten rows at once, across the furrows, about two and a half to three bushels of wheat to the acre. The ground is then harrowed the same way with the drill to cover the seed, and rolled if convenient.

The fourth year is wheat, which is hoed by hand in Lincolnshire, though horse-hoed in some other countries, and weeded thoroughly by hand once or more, as found necessary—all weeds being kept down through the season.

The wheat cut about August 20th and stacked with great care and skill, enough sheaves to yield four or five hundred bushels of wheat being often put into a single stack. The stacks carefully thatched and grouped about the farm-yard form one of the pleasantest features of an English landscape. Barns are not much used in England, all the grain and hay being stacked, and the farmers have the impression that their crops are thus more secure than if covered by buildings, which they think must exclude the air and occasion dampness—a notion which probably has little just foundation. The grain is threshed by steam-power, and yields from 28 to 30 bushels to the acre, the expense of threshing and cleaning being about five cents a bushel. Where twitch-grass appears, Bentall's scarifier, a capital implement, with four or six horses, is used; the land is then harrowed and rolled, and the twitch-grass is raked off and burned or carted away.

In November or December the wheat stubble is ploughed one inch deeper than for the wheat. In February it is cross-ploughed, harrowed, and rolled, and all weeds are removed. In May it is ploughed a third time and in June a fourth time, and each time well cleaned and rolled, and thus made very fine and firm. From the 7th of June to the 3d of July Swede turnips are sowed with a drill from 14 to 16 inches apart, 2½ to 3½ lbs. of seed being used to the acre. About 112 lbs. of super-phosphate of lime, 56 lbs. of Peruvian guano, and 10 bushels of ground bone, with rotted manure or turf ashes, enough to make in all fifty bushels to the acre, are drilled with the seed. The turnips are first hoed between the drills. Next they are "set out," as it is termed, by striking a nine-inch hoe through the rows across, thus leaving the plants in little tufts nine inches apart, all the rest being destroyed. Then, after a few days, the plants are "singled" by children, who pull out all the plants but one in each tuft; and the crop is once or twice horse-hoed and weeded, if necessary. The sheep are put on October 20th, which brings us again to the commencement of rotation.

We have thus given in detail the system almost universally pursued on what may be called light soil, or "turnip and barley land," which is not exactly suited to mangolds, beans, or peas.

The clay land is managed on what is called the "five-field system," which may be briefly described as follows: In February or March the land is ploughed as deep as possible with four horses. Early in May it is turned back, going the same way with three horses, and as soon as convenient it is cross-ploughed. In July it is "set up" in four-yard ridges, and manured with twelve tons of raw yard-manure ploughed in. Early in October three bushels to the acre of wheat are sown broadcast and ploughed in four inches deep and levelled with the harrow; "grips" or water-furrows for surface-draining are cleared between the ridges, if

necessary. In March, if dry enough, harrow with two horses and sow broadcast a half bushel of rye grass to the acre, and drill across the lands 14 lbs. of red clover, or cow grass, which is a kind of perennial clover, and roll, if desirable. The crop is kept clear of weeds by hand-weeding and cut about August 20th.

Thus we have the first year a naked fallow, which is considered indispensable to clean the land and expose it to the atmosphere. The Lincolnshire farmers are confident that this fallow cannot be properly omitted on their peculiar kind of clay. The second year is wheat. The third year is for grass. The stones are picked off and the thistles "spooded;" that is, cut out, and the stubble brushed down, if necessary. The grass is cut about June 20 for dry hay. The "eddish" or after-math is cut for horses, as required, or eaten off by sheep. In January or February of the fourth year ten tons of horse manure to the acre are applied, and the land is once ploughed, and without harrowing in February or March, from six to eight pecks of beans are "dibbed" between the furrows, one bean in a hole four inches apart, and the width of the furrows between the rows.

The beans should be covered with the harrow before night to prevent the crows and rooks and pigeons from carrying them away. The beans are hoed twice and hand-weeded as often as necessary. They are ripe the first week in October, when they are cut with a hook, put in "stooks," and stacked when sufficiently dry. The bean crop here described is different from anything known in New England, our season being too short for them. It is a large dark-colored bean, and used ground or whole, cooked or raw, for sheep, cattle and horses, and forming a valuable and considerable portion of the cattle feed of the country, the haulm or straw being also equal to oat or barley straw for fodder. After the crop is off, the land is scarified and plowed with three horses, and three bushels to the acre of red wheat are drilled or sown broadcast, as preferred.

In the fifth year the wheat crop is kept clean by hoes or hand-weeding, according to whether it was drilled or not, and harvested as before.

The next rotation is like the first, except that the crop of beans is omitted, so that four crops of wheat are taken off in nine years, the land lies fallow two years, is in grass two years, and gives one crop of beans. The barley and turnips are entirely omitted on this kind of soil.

The four-course or five-course system, which we have thus described as giving a correct idea of the general system of English husbandry, is by no means supposed to be adapted to American soil and climate in its details. In considering the differences of CLIMATE, we have suggested many obstacles in the way of adopting the common English rotations. Indeed, in England, itself, the artificial and almost mechanical rules upon which farmers formerly conducted their operations are fast giving way to a spirit of progress by which the principle and not the rule is kept in view. The best farmers are constantly varying their practice by an adaptation of their plans to the growing wants and improvements of the country. Facilities of land and water communication have opened distant markets for articles formerly difficult of transportation, while portable manures and cattle food by the same means may be brought home to repay the exhaustion caused by the abstraction of large crops of corn and of stock. Improved machines and more economical processes of husbandry allow of better culture at cheaper rates, while proximity to large markets for particular articles, as of milk or vegetables, and the facility of obtaining street or sewage manures, may render it expedient for the farmer to modify materially his established practices to suit the new order of things.

The great principle of English husbandry is often said to be to keep the land DRY, CLEAN, and RICH, and then any system likely to be adopted by intelligent and observing farmers will probably prove successful. Many of the high farmers are breaking away from even the standard crops in the old rotation. Turnips, which were long regarded as the foundation of the whole system, are failing in many localities, and mangolds are taking their place. By enriching his land so as to produce heavy crops of wheat, the high farmer has found his land too rich for barley, which is therefore omitted in the rotation, or sowed after a wheat crop in plain violation of the old principle once regarded as sacred, that one white crop should not succeed another.

No system of husbandry which should exclude Indian corn from its place in the rotation can be adapted to this country. It is the golden harvest of our land, the surest gift of the great Giver to our western world. For man, and for every animal upon the farm, it stands at the head of the list of cereal plants. As a fodder plant, green or dry, it may take the place of almost any other. Whether it might take the place of barley in a rotation consisting of wheat, grass, and roots, it is hardly possible yet to decide, for its exhaustive effects upon the soil are yet much in controversy. The common practice in New England is to follow Indian corn with wheat or oats, thus treating it rather as a green than as a white crop. A rotation of Indian corn, roots, wheat, and grass in the order in which they are named would be convenient for cultivation, provided the wheat be sown in spring, as it is the practice generally in America. If sowed in autumn, the root crop, if it consisted

of mangolds or turnips, would perhaps be necessarily upon the field too late for the wheat sowing. No other crop has usually been found so satisfactory to follow grass as Indian corn. Yet the English course is, to follow grass with wheat, and if this method were adopted with us, the course would be completed by a crop of roots and Indian corn. This, however, is an incomplete system, inasmuch as the land is not, in the ordinary course of husbandry, left in grass at the harvesting of the corn. We have often known the experiment successfully tried of sowing grass seed among the corn at the last hoeing, care being taken to hoe entirely flat, but it is difficult to leave the field sufficiently level, or to roll down the corn buts, so as to allow of the free motion of the scythe. A course better adapted to our present notions would be to allow the land about three years in grass, both followed and preceded by wheat, so that the rotation would extend through seven years, to wit, wheat, grass for three years, wheat, roots, and Indian corn.

An impression prevails in New England that grass does not flourish after grain which has followed turnips, but there is wanting yet evidence to satisfy us on this point. No such objection is made to the mangold, which has not however been cultivated extensively enough to justify any conclusions on the subject.

CAPITAL EMPLOYED ON ENGLISH FARMS.

The following estimates given us by our reliable friend, of the capital actually necessary to conduct profitably a thousand-acre farm in Lincolnshire, will assist in showing also the kind and quantity of live stock usually kept, and give many hints of the manner of conducting the farm operations. It is assumed that the tenant enters on his own farm on the 6th of April. For convenience the sums are given in dollars and cents instead of English currency:

To pay outgoing tenant	$10,000
1,000 sheep to keep	10,000
28 horses, 24 cart horses and 4 nags, at $180	5,040
8 wagons and six carts	1,530
Steam-engine and threshing-machine, (7 horse)	1,750
14 ploughs, harrows, and other implements	1,000
Cows and summer beasts	750
Furniture for house, riding gigs, &c	2,000
Tackling for 28 horses	350
Pigs and bacon	1,000
1 year's rent	5,500
Manure for turnips	2,500
60 beasts in October to sell	4,500
1,000 sheep to winter and sell	10,000
	55,920

To these items all the labor for the season is to be added, and also the feed for horses, and supplies for the family. On the other hand, the rent is not usually payable within the year, but one-half is payable in nine, the other in eighteen months, so that the wheat may be sold to pay part of it. The amount paid for labor depends very much upon the kind of crops, upon the condition of the farm, upon the price of labor, and upon the amount of machinery employed. Mr. Mechi, who is one of the leaders in "high farming," estimates his expenditures for labor of men and horses at about sixteen dollars per acre annually over his whole farm of 170 acres, and a great portion of the labor is performed by steam power. This, however, must be far beyond the amount expended for labor on farms in general. We observe a statement by Mr. Caird, that the labor on a good farm of 400 acres, visited by him in Hertfordshire, of which 140 acres was in grass, cost six dollars an acre annually; and this is perhaps as high as the average cost of labor per acre on most English farms.

"Manure for turnips" is noted as a large item of expenditure in the foregoing estimate, being equal to more than $10 per acre for the whole turnip land annually. We were everywhere struck with the liberality of the English farmers in purchasing manures and feed. The leading idea seemed everywhere to be to make the greatest possible quantity of manure. To procure a heavy crop of turnips is the first object, and super-phosphates, or bone, or guano are applied without stint. With turnips the sheep may be fed, and thus the land manured. The inquiry is not, How can I keep my flock of sheep so as to make a profit on them? but, How shall I feed sheep enough to manure my land for the rotation? Mr. Pusey says (in a published statement) that, "in many instances, the farmer pays as much to the manure merchant as he does to his landlord. I know one instance where a farmer pays

7*s.* to 8*s.* ($1 75 to $2) an acre for rent on a farm of 1,000 acres, and he pays £1 ($5) an acre for artificial manure every year."

The first item of $10,000 to pay the outgoing tenant is a shifting amount, depending on the course of husbandry on the particular farm at the time when the new tenant comes in, and depending, too, not usually on any written lease or any special agreement, but upon the custom of the place as to what is termed tenant-right.

Tenant-right is the right which a tenant who is leaving a farm has to payment for his labor and expenses contributed to the crops of succeeding years. It is the nature of compensation for unexhausted improvements. The tenant who leaves, for instance, on the 6th of April has already incurred all the cost of the crops of wheat for the current year, the wheat being usually sowed in autumn. A glance at the rotation already given will indicate very nearly what would be the basis of an estimate of the tenant-right in Lincolnshire.

The matter is usually arranged by appraisers, consisting of three of the most intelligent farmers of the district, who are so situated as to be as impartial as any other tribunal, their sympathy with the tenant naturally balancing any interest they might have to maintain friendly relations with the landlord or his agent. The practice is for the appraisers to make their award in a gross sum, so as to leave no room for criticism as to details. From the same person who gave us the items of capital employed in conducting a thousand-acre farm, and who has often acted as an appraiser in such cases, we obtained the following specification of items which would ordinarily compose the sum paid to the outgoing tenant:

Wheat sowed, 250 acres, at $12 50 per acre	$3,125
Turnip "management" (manure) $2 50 per acre	2,500
Oil cake used for sheep in past two years and a quarter	1,250
"Seeds," *i. e.*, land seeded to grass	1,000
Ploughing 300 acres, at $2 per acre	600
Hauling manure, &c.	375
Fixtures in farm-yard	1,150
	10,000

However fair and competent may be the board of appraisers, a glance at the items will show that this system is liable to great objections. The tenants rely upon it as affording them even better security than a long lease, as it seems to be pretty well understood that the outgoing tenant usually receives a liberal compensation. He has possession of the land, and the evidence as to his invisible manurings and other improvements must come from himself. The second item, of manure applied to the turnip crop, would ordinarily be proved by the receipted bills of super-phosphate and guano purchased by the tenant. The third item, of oil cake used in feeding sheep in the past two years, is based upon the idea that the tenant has fed the sheep upon the turnip land with oil cake for the purpose of manuring it more thoroughly, and that this manuring is yet unexhausted, and to benefit the incoming tenant in the crops of barley and "seeds" which follow the turnip crop. The objections to the system are, first, that the tenant has less security under it than under a well-defined lease for a term of years, and that he is under constant temptation to arrange his plans with a view to a good speculation, in the event of losing his farm, rather than to the most profitable agricultural results, while the landlord is subject to the risk of constant changes of his tenants, and the farm to constant changes in its system of cultivation. Although in Lincolnshire, as has been suggested, the terms seem almost as permanent as if the farmers owned the land in fee, and the objections to tenant-right are, therefore, little felt, it is found in other countries that this system is almost destructive of good husbandry.

An experienced land agent of Surrey spoke of this custom before a Parliamentary Committee, in 1848, as promoting an extensive system of fraud and falsehood among farmers. He states that the outgoing tenants systematically prepare for quitting by putting in manure of an inferior quality, intending to have it appraised as of full value. In some countries it is said that a class of land valuers and appraisers have grown up, who live by acting as arbiters in those cases, and whose business depends upon the changes constantly occurring in the tenancy of the farms in their neighborhood. These objections, it will be observed, apply rather to the manner in which this custom is exercised than to the principle of compensation for unexhausted improvements; but, in the language of the witness referred to, "the tendency in Surrey has been to lower the rent of farms as compared with other parts of England, and to have the same money paid for bad as good farming;" and it is fair enough to infer that the effect is the same elsewhere wherever changes of tenants are of frequent occurrence.

Mr. Caird, in a minute account of a farm in Northamptonshire, in 1851, confirms our view of the capital necessary to conduct a farm on the four-shift system: "The farm con-

tains 630 acres, 480 of which are arable, and 150 acres in permanent grass. The arable is managed in the four-course system of 120 acres in each division, very nearly as we have described the course in Lincolnshire on the light soil. The whole implements were bought two years ago quite new, and, with the live stock, cost the tenant $17,500. His invested capital altogether amounted to $30 an acre; but there is here no draining, building, or permanent improvements which the tenant has either to execute himself or to aid in doing. He has just to stock and work an easy, light-land farm."

We have given $50 an acre as the estimated capital necessary to conduct a Lincolnshire farm of mixed character, and Mr. Caird suggests the reason why the capital, in his account, should be less than on a heavier soil.

A writer in the Cyclopedia of Agriculture gives thirty to forty-two dollars per acre as the average capital employed on English farms, an amount larger than the capital usually employed in America, in the purchase in fee-simple of the farm, and in its cultivation.

To show how it is practicable for the farmer to meet his large payments for rent and labor and interest of capital, we give the three principal crops usually produced on the 1,000-acre farm, with the estimated value, for 1859:

250 acres of wheat, 26 bushels to the acre, 5,500 bushels, at $1 75	$9,625
250 acres of barley, 32 bushels to the acre, 8,000 bushels, at $1 25	10,000
Wool from 1,000 sheep, 8½ pounds to each, 8,500 pounds, at 62 cents	5,270
	24,895

These are the principal crops sold. The cattle kept and fattened are reckoned to afford no profit beyond their manure. Large expenditures are made annually for oil cake and for super-phosphates and guano. When estimating the expenses of his crops, the English farmer, who is not ordinarily disposed to exhibit his farm accounts, is in the habit of replying to the inquiry how much he pays for manure by saying: "All the money we have left."

It is extremely difficult to obtain accurate statistics of English husbandry. Every attempt to enact laws to obtain accurate returns of the live stock and farm products of England has failed, through the opposition, it is said, of the farmers, who seem unwilling that the productiveness of their farms should be published lest their rents should be raised.

The relation of Landlord and Tenant is, perhaps, to an American, the most striking feature of English agricultural life. It is, as has already been seen, a legitimate and natural if not a necessary result of the aristocratic principle of the British Constitution. Allusion has already been made to some of the effects of the accumulation of land and capital in few hands upon the productiveness of the soil. It is now proposed to examine more in detail the relation of landlord and tenant, and its reciprocal effect upon the parties, as well as upon the agriculture of the country. The impression seemed to be general in those parts of England where we had opportunity for personal intercourse with farmers that leased lands are better cultivated than lands occupied by their owners who are of the same rank as farmers.

In travelling with intelligent farmers over a large portion of England, we found that they professed to distinguish, by mere observation, leased lands from those of small proprietors. Whenever we passed a farm half-drained, and with crops feeble and uneven, the remark was made: "That man owns his farm; if he paid rent he could not afford to farm like that." Occasionally, too, we would hear the suggestion, when a farm was noticed as being in ill condition, "That farmer ought to have his rent doubled, and he would be compelled to raise better crops." These remarks seemed based upon the idea, which certainly is founded in human nature, that an additional stimulus to energy and industry would make a good farmer of a poor one. We are not, however, inclined to admit that the stimulus of a high rent to be paid operates more forcibly upon men in general than the just pride of ownership and ambition to succeed and excel. We believe that the feeling which pervades the aristocracy of England, that the true dignity rests upon the foundation of broad estates in lands, might be extended to a class more numerous, and that the attachment to home, so much more strong in England now than in America, and so promotive of every grace and humble virtue, would be strengthened by the consciousness that no stranger could intermeddle with its permanency.

Our solution of the question why leased lands are better tilled than others in England, if we must admit the fact, would be, that more capital is employed upon them. In England, as here, every man is ambitious to own land, and to add field to field. He feels that land is *real* estate, and that all else is unsubstantial. He invests, therefore, all his capital in land, and has nothing left with which to cultivate it with a liberal hand.

The effect there is the same as here. Land cannot be well cultivated without a liberal working capital; it cannot give without receiving; and he who in England expends all his

money for land is in the same condition with him who should take a lease of a large farm with no means to conduct its operations. It is not that he is the owner of the land which renders him a poor farmer, but that he is not also the possessor of capital with which to develop its productiveness.

The best cultivated estates in all England are those of the wealthy proprietors. To them is the country indebted for the introduction of improved implements, the threshing-machine, the reaper, the steam plough; for improved processes in culture; for improved breeds of cattle, sheep, and horses; for extensive experiments in reclaiming land from the ocean, and in embanking and draining, and for illustrations of the capacity of soils for large productions. It is only where the owner of land is the owner of nothing else that his ownership is legitimately the reason for his bad husbandry.

An English writer has said, with great significance, that the best lease is that which is as *like ownership* as it can be made.

The greater proportion of English farms, it is supposed, are still held by yearly tenure, which may be terminated at any time by a six months' notice on either side. The first impression would be that infinite vicissitude and confusion must ensue, and that in spring a general marching and countermarching, with household gods, and goods and chattels, like what is witnessed in New York on the 1st of May, from tenement to tenement, must confound the whole kingdom. No such commotion, however, is witnessed. In general the tenant remains and expects to remain quietly on his farm, and it is quite common that he spends his life there, and that after his death the lease is continued to his eldest son. The landlord prefers this tenancy at will because he thus retains a greater control over his land and over his tenants. The tenant submits to it because, in truth, he cannot do otherwise. There is great competition for farms. The oldest son may have his father's lease, but there are other sons who have no other business but agriculture, for whom it is difficult to find farms. We frequently conversed with farmers on this point, and often found that they were prospering under their present arrangement, and preferred to keep quietly on from year to year under this verbal agreement rather than have a lease for a term of years, because they said at the end of such a lease the farm would be re-valued and their rents probably raised, in consequence of the very improvements they had made during the term.

The permanency of the relation of landlord and tenant in England, it is but just to say, results in great measure from the mutual confidence of the parties. The English landlords as a class are men of honorable and generous character. They have a just pride in seeing on their estates a prosperous and happy tenantry, and in enjoying the reputation of dealing liberally with their inferiors. The tenants have usually the utmost confidence that no unfair advantage will be taken of them, and custom and their unbounded reverence for rank seemed to have dulled their sense of their dependence. They invest their capital often in permanent improvements, where no custom of tenant-right exists, and trust to the honor of the landlord for their security.

Occasionally, however, instances of great hardship occur where tenants, for causes quite frivolous, are compelled to leave their farms and their homes broken up, to the great injury of their pecuniary interests as well as to the sacrifice of their domestic arrangements.

The preservation of game, of which we shall have occasion to speak in another place, is one of the most fertile sources of difficulty between landlord and tenant, and a relic of barbarism inconsistent with the present enlightened condition of the British nation.

The question has been from time to time agitated in England, whether the custom of tenant-right should be legalized, so as to render it general and uniform over the kingdom; but this question has been met by the objection that the welfare of the agricultural interest would not be thereby promoted, but that the entire abolition of the custom would be far more beneficial. The better opinion seems to be that the counties where the tenant-right custom exists are, on the whole, not so well cultivated as other counties, and that it has not only led to frauds, but has perpetuated bad husbandry by retaining useless practices which would have become obsolete had they not been connected with these ancient usages.

The tendency of public sentiment of late years is toward permanent leases, or leases for long terms. One objection to long leases heretofore has been, on the part of tenants, that in times of depression of prices they would be compelled to continue the payments of their rents in a losing business, and so might be ruined. On the other hand, enterprising farmers, desirous of increasing the productiveness of their farms by permanent improvements like drainage, the cost of which their landlords were unwilling to pay, have been compelled to sit down and try to content themselves with the old routine of business, because they had no assurance that they might not, by some freak of their landlord or his agent, at the end of the year, lose both improvement and lease. As agriculture becomes more of a science, more capital is necessary to conduct its operations; and as the farmer improves by education, and, by reason of new travelling facilities, sees more of the world, he takes broader views of his rights, and becomes uneasy at the dependence of his position. He is unwilling to employ so much capital, with so little assurance of security for the future, and he learns that not-

withstanding the fluctuations of prices he may, in a long term of years, count safely on their averages, and on the whole prefers a long lease.

The interest of the landlord, too, lies in the same direction. In a tenancy at will he is liable, in a time of depression, to have his whole estate thrown back at once upon his hands, especially should there be some combination among the tenants to reduce the rent. Under the tenant-right custom, he may not only have all the leases surrendered, but be compelled to pay the appraised value of the unexhausted improvements, amounting sometimes to fifteen or even twenty-five dollars per acre.

We believe that every reason of interest and convenience of both parties requires that leases should not only be written and definite, but that they should be made for long terms, and the true independence of the farmer imperatively demands this. A lease should be long enough to allow the tenant to reap the full benefit of any capital he may invest in improvement. How long this may be it is difficult, perhaps, to determine. Twenty-one years has been advocated as the term most convenient, but in our view the larger the better until it reach the fee-simple.

In reviewing the foregoing comparison of English and American agriculture, we may be able, perhaps, to determine to what causes may be fairly attributed the superior productiveness of the former. We see that large estates and the relation of landlord and tenant necessarily result from what we have termed the aristocratic element of the British Constitution.

We perceive, too, that the control of large estates by single proprietors or their agents naturally tends to induce a systematic course of husbandry, and that the employment of large numbers of laborers on the same estate permanently leads to a division of labor, and as a consequence to greater skill in those processes, like ploughing and ditching, which depend upon mere manual dexterity. It is to be expected that a man who holds a plough nearly every day of his life will acquire a skill as ploughman beyond that of him who ploughs but four or five days in the year.

We have seen, too, that without the liberal use of capital the present system of farming could not be maintained in England. The capital thus employed, however, is not for the most part that of the landlord, although he is usually a generous contributor to the permanent improvements on the farm. As has already been seen, the farmer invests a large capital in his systematic course of cultivation, and therefore the fact that capital is largely employed in agriculture in England is not due to anything peculiar to British institutions.

The same farmer who expends thirty dollars an acre on an English farm might, in this country, in many localities, purchase the farm with a year's rent, and employ his capital in his farm operations. There is no doubt that the great want of American agriculture is the employment of adequate capital.

The low prices of wages of the English laborer is usually pointed to as the secret of the prosperity of the English farmer. It is certainly true that they could not at the same time pay their rents and taxes, and at present prices of their products pay American prices of labor; and it is equally true that from the accumulation of property in few hands, the degraded condition and low wages of the laborer naturally result. While to a British subject it may seem impossible that society should exist without these sharp divisions of rank and station, and that it is essentially just that an aristocracy should be supported in elegance and luxury, at the expense of degradation and poverty suffered by ten times the number of their fellow men, we cannot, with our republican principles, recognize in this the true adjustment of our natural rights. While we admit that with the enormous burdens which royalty and a hereditary aristocracy impose upon the British nation, it is difficult to see how farm labor can be better paid there than it now is, we can clearly perceive that cheap labor is not so essential to our own success.

There the laborer works, first to support an expensive government, made more burdensome by the increasing interest of a vast national debt, then to pay the farmer his heavy rents and taxes, and finally to receive for himself the smallest pittance consistent with maintaining his physical ability for labor. Here the expenses of government, both national and state, are comparatively light; we have inherited from our ancestors no national debt, and the lands are burdened with no claim of landlords to yearly rents. In most of the country the same man is landlord and farmer and laborer, and in the latter capacity he divides with no man the fruits of his labor. His superior education ought fully to compensate, by his better adaptation of labor, for the manual skill acquired by constant practice in a particular department.

Our prices of farm products are somewhat lower than those of England, but the cheapness of our lands should save to us more than this difference in prices.

Allowance is to be made for the unsettled condition of a shifting population in a new country, and for the constant interruption of agricultural plans by its progress and prosperity. Scarcely has the settler cleared his farm in Western New York before the opening of a new territory in Illinois, and the increased value of his clearing, tempt him further westward; and no sooner has he located anew and commenced a homestead upon the

prairie, than some city like Chicago springs up by his side, and he finds his land again too valuable to retain for corn-fields or the pasture of his stock. Thus all system and thorough knowledge of the capabilities of the soil are prevented. Our citizens do not remain long enough in one place to establish correct principles of agriculture. They take what Nature yields spontaneously, and when she makes the first suggestion of exhaustion move onward to new and fertile lands.

We are without system not because our political institutions prevent or discourage system, but because we have had yet neither time nor occasion to develop system.

We may explain, too, the want of capital in American agriculture, without disparagement to our system of government. So many enterprises are constantly opening to us, that the rate of interest is far higher here than in England, and the low percentage of profit on money invested in agriculture which is perfectly satisfactory to an English capitalist can attract no money to the soil in America.

To the superior intelligence of the laboring classes in our country we look for compensation for much of the difference in the wages of labor. Our laborers earn a higher price than the laborers of England because they bring to the field the head as well as the hand, more discretion, more judgment, more manliness, and more capacity. We have said already that in the mere routine of common farm operations the English laborer exercises more skill in matters depending on mere dexterity than the American, and so far as physical force and endurance go we should perhaps claim no superiority. The English or Irish laborer, in his own place, at the plough, spade, or hoe, is not excelled by the American; but in the capacity to adapt himself to new conditions, to learn new processes, to handle improved implements, in short, in all progressive movements, the American is far superior to the English laborer.

The American is continuing always to economize his labor, to work more with his head and less with his hand. He will not waste his muscle if his wits can in any way save it. If the muscle of the horse will do the work, the American prefers to drive the horse, and has skill to do so; and again, if the giant steam may be chained to the plough, he is still equal to the task of guiding this power.

In all farm implements the American is far in advance of the English farmer. Our small tools, such as rakes, hoes, spades, and forks, are lighter, neater, and in all respects better than the English. We have frequently seen a scythe snath in the hands of an English mower so roughly made that the end of it showed the cut of the axe which severed the sapling from the stump; and such hand-rakes as we saw in use appeared to have been made by the laborers themselves, not so well finished as one which any farmer's boy in New England could readily fashion. In mowing and reaping machines we have constantly kept the lead of England, furnishing her the only successful models for her own use, and in steam ploughing we seem destined speedily to exceed the largest conceptions of her inventors. The number of reaping and mowing machines manufactured in the single State of Ohio in 1857 was about seven thousand, which is seven times as many as in all England for either that year or 1858. Mr. Caird, from whose "Prairie Farming in America" we state the above fact, thus announces his opinion as to the effect of American improvements upon the cost of production in the somewhat peculiar husbandry of the prairies:

"Manual labor is 100 per cent. dearer in Illinois than in England, but the cost of keeping horses is 100 per cent. cheaper; and as a larger proportion of the work of the farmer is done in America by power and machinery than in England, the cheapness of horse labor will fully compensate the prairie farmer for the dearness of manual labor. The cost of production in so far as labor is concerned is thus much alike in the two countries." The same writer states that the extent to which labor is economized in the State of Ohio by steam power is estimated to be equal to the labor of 700,000 men.

The effect of general education upon the laborer we conceive to be not so much to increase his capacity for a given day's work, as to enable him to use implements and processes requiring a higher degree of intelligence to attain his results.

II. THE CLIMATE OF ENGLAND—HOW IT AFFECTS AGRICULTURE.

ITS EFFECT ON CROPS—ON KEEPING LIVE STOCK—ON FARM OPERATIONS—COMPARISON OF RAINFALL AND EVAPORATION IN GREAT BRITAIN AND THE UNITED STATES.

In any endeavor to profit by observation of the agriculture of foreign nations the diversities of climate must be constantly kept in mind. The laws of nature define certain bounds for the cultivation of certain crops which may not be transcended by the art of man. The conditions of light and heat, and moisture, are among those most manifest to our senses, upon which the growth of plants depends; but it will be perceived, upon slight reflection, that it is not the average amount or degree of these for the year which determines the fitness

or unfitness of a particular country or district for the production of a given crop. Indian corn cannot be grown in England, because, as we say in popular language, the climate is not warm enough; yet it flourishes and is the surest of all crops in New England, where the bean, which is so extensively grown in England for stock, cannot be cultivated because it is too cold! Our climate is, indeed, warm enough for Indian corn, but too cold for the bean; while the climate of England is not hot enough for Indian corn, but warm enough for the bean!

Indian corn requires at Red River valley, latitude 50°, but about 60 days of clear tropical summer to perfect it beyond the reach of frost, and but about 100 days in latitude 43°, and that we always have in New England, and that is such a summer as Old England never sees; while the bean requires a long season of mild and shady weather to produce it in perfection, and such is the character of the climate of most of England. The only specimen of Indian corn culture which we chanced to meet with in England was in a lady's flower garden, in Suffolk county, to which we were triumphantly taken by the fair proprietor, to show that Indian corn will grow in that climate. The corn was sown in drills, about eight inches apart, and as thick as wheat is usually sown, and in the shade of large trees, and looked more like barn grass than corn. The lady, however, exhibited two or three little nubbins of ripe corn which she had raised the previous year. Americans are much inclined to amuse themselves with the peculiarities of English climate. One has passed six weeks in England and never saw a ray of sunshine; another declares that the sun in his greatest glory there never presents a more brilliant appearance than a boiled turnip; while a third asserts that in a year's residence in that country the only ripe fruit he ever ate was a baked apple!

Compared with that of our own country, the climate of England is mild and equable, the thermometer seldom rising in summer above 80° Fahrenheit, and rarely falling below 20° at any season. Although, as will presently appear more definitively, there is actually far less fall of rain even in summer in England than in the United States, yet England may well be called a moist climate, while ours is properly termed a dry climate.

To bring out clearly to view the influence of climate upon the agriculture of England, it may, perhaps, be convenient to consider the subject under separate heads as it affects—1st, the products of the soil; 2d, the keeping of live stock; 3d, farm operations.

The agriculture of England is very simple. Four crops in a regular rotation, and mainly in the same order, constitute her great staples. Wheat, turnips, barley, and grass are the four watchwords at which the earth unlocks her treasures to the English farmer. Wheat to furnish bread for the people; turnips to feed the sheep, that furnish clothing and mutton; barley to be malted for beer; and grass, in pasture, meadow, and field, for the cattle, which give supplies of beef and dairy products. The occasional crop of oats instead of wheat, and of beans instead of turnips, and the culture of special crops, as of hops in Kent, and of flax in Yorkshire, scarcely interrupt the general system of the kingdom.

Under the head of grass, not with technical accuracy, we have included what are not strictly grasses, such as clover, and vetches or tares, which have place in the four-year course under the name of "seeds," a name which, in New England, is never used to indicate this crop, or indeed any other. The mangold wurzel, too, has of late been extensively introduced in place of the turnip, and is likely to constitute a valuable acquisition to the agriculture both of this country and of England.

Wheat is adapted to a very wide range of soil and climate, though it seems difficult to assign to it precise limits. Blodgett says that it grows at no great altitude above the sea at the borders of the tropics, and flourishes as far north as 60°; yet, he says, notwithstanding this possible range of growth, there are practical limitations of soil and climate which control its successful cultivation on the ample scale which the demand for the bread grains requires. According to the same learned writer, the wheat crop manifests a sensitiveness to climatic influences far greater than is generally imagined. "In England," he says, "the value of a crop of wheat is probably greater on any definite area than in any other part of the world except California; yet half the island is too cool for it, and a slight depression of the temperature for one ripening month will greatly reduce the quantity, or prevent ripening altogether. The summer of 1853, in England, was nearly 2° below the mean, and the deficiency in the crop in consequence was one-third to one-half the average. For the months of July and August the mean was at 57° to 59°, the mean of 60° for these months being essential to a good crop." We understand him, however, to state that in less humid climates this small range of temperature for the ripening months does not limit the growth of wheat, but that it may run as high as 70°, if the atmosphere be dry as well as hot. The limitation of profitable wheat-growing seems to be on the side of cold not less than 58° for the equable climates, and 65° for the variable, and at least two months free from frosts. On the warm side the only requirement outside the tropics is a period of growth free from humid tropical heats. Where these exist, they originate rust and mildew, which are fatal to the crop.

The adaptation of manures to the increased production of the wheat crop, without doubt, depends much upon the climate. Manures, the effect of which results chiefly from their ammonia, as Peruvian guano, exert an influence in promoting growth on all soils, if properly applied, so as not to be dissipated at once by exposure. Those manures depend much upon the degree of moisture, both of soil and atmosphere, for their value in producing wheat. In a wet, cold climate or season a large application of ammonia tends to produce a heavy growth of straw, and the crop is likely to be lodged or "laid," as it is expressed in England, and the farmer to be disappointed. Seven pounds of wheat to ten of straw is said to be the most productive crop. Peruvian guano applied on the surface in a hot, dry climate must be mainly lost in the atmosphere, while in a moist climate it might prove very beneficial. Its application, both as to method and amount, must therefore be regulated according to the average character of the climate where the farm is situated, as well as the condition of the particular field to be cropped.

Although wheat is a principal crop almost everywhere in England, as well on the light "turnip and barley soils," as they are termed, as on heavy clays, and on the fens of Lincolnshire, yet the variety and quality of the wheat sown, as well as the crop, vary much with the climate and soil of the different localities.

Barley (the crop of grain in England second in value only to wheat, and which occupies so important a place in the common rotation there) is said to have a range of growth still wider than wheat, so far as temperature is concerned. Blodgett says that barley, with oats and rye, go into colder and more humid climates than wheat by nearly 5° of mean temperature. They everywhere bear cooler summers, poorer soil, and a shorter period of growth. "Barley," he says, "is the most flexible of all, ripening its grain in the short summer at the Arctic circle, on the west of Norway, and going nearly as far on the Mackenzie river, in America."

Barley, although well adapted to the varied climate of our country, will probably never be extensively cultivated in America, because the demand for it, in comparison with wheat, must be limited. The product of barley in this country by the census of 1850 appears to have been but 5,167,015 bushels, or about one-twentieth of wheat. Most of the barley produced in England is malted for beer and other fermented beverages, and is valuable in the market not so much for its weight as for its malting qualities. Everybody drinks malt liquors in England—ladies and gentlemen, farmers and servants and laborers. In the hiring of servants, male and female, it is common to stipulate that a certain quantity of ale daily shall be given, in addition to the wages. Some idea of the enormous consumption of malt liquors in England may be formed by the amount of the excise or tax levied by the government upon malt, which is stated for the year 1856, when reduced to our currency, at $33,381,745. This sum of more than thirty millions of dollars a year is paid by the brewers to the government for the privilege of converting barley into malt. Large sums are also paid by all sellers of beer at wholesale and retail for their licenses, as well as the stamp duties payable upon every business transaction in England, which, of course, fall upon all who buy and sell malt or any of its products.

We cannot better bring out the operation of these duties upon agriculture than by quoting a few lines from the Mark Lane Express, signed by a well-known friend of agriculture, John Hudson, of Castleacre, published the present year of 1860 :

"I question whether any of the members of the House of Commons, who make our laws and impose the taxes upon us, ever made a calculation of the amount of money the produce of an acre of barley pays in the shape of malt duty; therefore I will take the liberty just to inform them.

"An acre of Norfolk land, rented at twenty-five shillings, will produce five quarters of barley, which, being made into malt, the duty is £1 1*s.* 8*d.* per quarter, and five per cent., or £5 13*s.* 9*d.* per acre.

"Now, I grow two hundred acres of barley every year, which, at the above sum of £5 13*s.* 9*d.* per acre, amounts to £1,137 10*s.* The rent of the two hundred acres of land the barley grows upon is £250, making a difference of £887 10*s.*

"The malt tax is about equal to the rent of the whole farm."

This enormous tax is paid, of course, by those who drink the beer, and those are the laboring classes, mainly, who are unable to indulge in more expensive liquors.

Our belief is that this whole consumption of barley for beer is a loss, and worse than a loss, to the country ; that the enormous consumption of these half intoxicating liquors stupefies and brutalizes the English laborers, and that the same product of grain converted into bread and consumed by the same classes would conduce vastly to their comfort and prosperity. It is to be hoped that the culture of barley, for the purposes to which it is applied in England, will never find favor in America. Generally, wheat and oats may be substituted for barley, and barley, if grown, may be made valuable for the food of almost all kinds of live stock.

In general we may safely conclude that, in the northern and western portions of our country, there is no obstacle of climate, either as to temperature or moisture, to the adoption of the English four-field rotation, so far as wheat and barley are concerned.

CLIMATE AFFECTS THE KEEPING OF LIVE STOCK in many respects, both directly and indirectly.

The sheep is adapted to almost every climate, from the poles to the tropics; but the sheep husbandry of England depends, or has been thought to depend, almost entirely upon the turnip. In those parts of England where turnips do not thrive the proper sheep husbandry does not exist. Wherever a full crop of turnips is produced, there may be kept the flock of sheep to manure the field, wholly or in part, for the whole rotation, and the crops of wheat and turnips, barley and "seeds," may follow in endless succession. Strike out the turnip crop, and the sheep cannot be fed, the land cannot be thus manured, and the whole system must be changed. Cattle feeding and the dairy take the place of sheep husbandry, or a mixed system is introduced. Of late the turnip crop has been failing, and mangold wurzel is, to some extent, taking its place. How far it may probably prove to be a substitute for the turnip for sheep feeding, or take the place of the turnip in the ordinary rotation, it might be interesting to consider. The turnip crop is best adapted to what in England is termed a light soil, but that expression hardly conveys to us a correct idea; for many soils which we, in New England, should call heavy soils, would there be found light enough for turnips. The soils called, in England, stiff clays, are heavier than any with us which are under cultivation, and are there only made profitable by thorough drainage and the most expensive treatment. Still, there are no lands in England so light that they may not, by their familiar processes of claying and of treading with sheep, be made productive of turnips. Indeed, the whole four-year course of husbandry originated on the light lands of Norfolk, and is known generally as the Norfolk system. So great has been deemed the advantage of this system that, on land so heavy as to be greatly injured by the treading of sheep, movable sheds have been adopted by some of those who practice "high farming." These sheds are of wood, with open, raftered bottoms, large enough to contain twelve sheep, and are made with wheels, to push forward on movable rails over the turnip field, for the double purpose of manuring the land without treading it, and of sheltering the animals. The crop is thus consumed, and the cost of drawing it off and bringing back the manure is saved. The turnips are, of course, pulled, cut, and fed to the sheep in troughs. The same rails, it may be remarked in passing, are used for removing manure from feeding houses to the field or compost heap, and for returning crops to the farm-yards. Thus has the turnip area been, as much as is practicable, enlarged, but yet the dryness of soil and climate is seen to be an important element in the question of sheep growing.

Temperature has obviously a controlling influence upon all plans for keeping animals. In New England, as early as the 1st of December, the ground is usually closed by frost, to remain until April, so that no plough can enter it, and no turnip or other root can be drawn from it, and no sheep or other animal, unsheltered from the pitiless blasts, can exist in our fields. The climate, by its severity, without regard to its effect upon the productions of the soil, would prevent the adoption of the English system of feeding in New England. Our winters are not only more severe, but they are also longer, so that we must lay up a greater store of food for all our animals.

SHELTER, too, against the cold and the sudden changes of temperature, which are much greater and more frequent here, is an important consideration incident to climate. In New England the barn is as essential to the farm as is the house, and often as expensive. It is large enough to shelter all the live stock of the farm in winter, to contain all the hay cut upon the fields, and all the grain unthreshed. Often it has a cellar under its whole extent, to preserve manure from freezing, to store roots for the animals, and to protect the farm implements from the weather. In England the sheep, generally, are kept on the turnip fields during the winter, or, at most, require the shelter of an open shed; the farm horses and cattle are, except when the latter are fattening, protected only by low sheds, covered with thatch; while the hay, and the wheat, and barley, and oats, are heaped in large stacks in the farm-yard, protected from the weather by a covering of thatch. Riding and driving horses, or, as our Lincolnshire friends called them, "nag horses," are much better cared for, being kept in warm stables—often in square "box stalls," and blanketed.

We often conversed with farmers upon the subject of stacking their grain and hay. They were not familiar with the idea of sheltering their crops in barns, and uniformly expressed the opinion that hay and grain would spoil from dampness thus closely housed in their damp atmosphere. Wheat is frequently kept many months in the stack before threshing. It is stacked in immense stacks, so large that we, in one instance, saw a man on the back of a large draught horse on the top of one of them, treading down the straw as it was pitched up from several wagons, and presenting the appearance of an equestrian statue, quite as imposing as that of the Duke of Wellington in Hyde Park, and far more picturesque. The poor animal worked his way to this proud eminence by gradually rising upon the straw, as

pitched on, and was to be cast, when he had attained the summit of his ambition, and tied neck and heels, and ignominiously lowered by ropes passing over the stack, held by men upon the ground on one side, while the poor steed slid gently down the other to *terra firma*.

There are serious objections to this method of keeping crops. The stack cannot be secured against the weather until it is completed, so that if a long storm comes upon it when it is half built up, the rain must penetrate into the sheaves, or hay, and do much injury; and this is one reason why "a wet harvest" is regarded in England as so injurious. After the stack is raised it is often thatched with great care and skill, at great cost of time, and unless secured, as is usually practiced now by good farmers, on iron bottoms or frames, the grain or hay is liable to injury from dampness from below, as well as from vermin. The farmers who had one thousand acre farms, and raised six or seven thousand bushels of wheat, and as much barley, seemed to think it impossible to protect it all in barns. Lumber is scarce there, and who could build such structures? The tenants could not afford such an expenditure on the land of another, and the landlord would not add so much capital to the farm.

There is nothing in an English landscape more significant—at the same time, of abundance, and of taste for picturesque effect—than the arrangement of what is called the "crewe yard," with its rich stacks in scores, and surrounded by the farm buildings, with cattle, horses, and swine, standing in straw to their knees, and close beside "an English home—all things in order stored—a haunt of ancient peace."

Climate affects farm operations in many particulars. While, as has been observed, New England soil is locked up for at least four months by frost, in the greater part of England farming operations go on through every month in the year.

A Lincolnshire friend wrote us, in the spring of 1858, that there had been, during the whole previous winter, but five days when the plough could not be used upon his farm; and he expressed surprise that, in our cold New England climate, agriculture could be pursued at all as a business. Not only the absence of frost, but the small amount of rain, and its fall in gentle showers, add much to the comfort and convenience of the farmer. Other considerations, more carefully treated under the head of drainage, will illustrate the advantages of the mild and uniform climate of England.

In such a climate it is evident that a far less force is available to conduct the operations of the farm. While, in New England, we impatiently and almost idly wait for the loosing of the frost fetters in spring, and with scanty time, and greatest haste, and all available "help," hurry every process of ploughing and sowing and planting, and have not time to go over much breadth of soil, before the sudden transition from winter to tropical summer calls our attention to the hoeing and cleaning of the plants, which spring up as if by enchantment, and to haying and harvesting, which follow so closely, the English farmer goes deliberately on, ploughing on some part of his farm in every month, sowing his barley at any time before the second week in April, his Swedes at any time in June, his wheat at any time between the 1st of October and the 20th of November, having ample time thoroughly to perform every process.

Again, in summer, over all the United States, we are subject to severe periods of drought, which cuts off the feed of our pastures, in which the cattle for a few weeks in May and June have been thriving, rendering it necessary for dairymen to feed their cows at the barn daily, or lose half their flow of milk, while, in England, the moist atmosphere keeps the herbage green through all the summer, giving from spring to autumn a uniform and abundant supply.

A careful study of the English system of cropping, and especially of their green crops for soiling, might essentially aid us in carrying our animals, particularly our dairy stock, well through the summer droughts. The practice of sowing winter rye and Indian corn for summer feeding to cows prevails extensively in New England. Clover also affords a bountiful and convenient crop for soiling, coming into use after the winter rye and before the Indian corn.

In Massachusetts some of the most distinguished farmers near large markets practice altogether the system of house feeding their cows through the year. They thus keep a much larger stock upon a given area; they nearly or quite double their quantity of manure, and they produce at least an equal quantity of milk, with the advantage of a uniform yield through the year. Cows thus kept are always in high condition, and fit for the butcher; and it is claimed that the additional labor of cutting their fodder, and carrying it to them, is thus far more than compensated.

A little treatise upon soiling by the venerable Josiah Quincy, of Massachusetts, who has practiced for fifty years the system which he advocates, is referred to, as containing the best practical directions for this method of feeding dairy stock. In England, the crop of tares or vetches makes an important part of the green food of cattle and horses and sheep. We are not aware that this crop is grown anywhere in this country to any considerable extent. Vetches are not well adapted to drying for hay; and summer feeding of cattle with green

fodder has not yet attracted general attention to such crops as in other countries are used for the purpose.

Ryegrass of various species is used in England not only in permanent fields and pastures, but especially in the usual rotation; this grass taking a conspicuous place in what constitutes "seeds" in their vocabulary. The yield of these grasses is very great, and, as they are gross feeders, enormous crops may be produced by liquid manuring and frequent cutting; six or seven soiling crops being in this way sometimes afforded in a single year. The Patent Office has for several years distributed seeds of this grass, and its value to American agriculture, which is not generally known, may be soon ascertained. It is probable, however, that the moist, cool summers of England are more favorable to the production of ryegrass than the dry, hot seasons of our country. There seems to be no reason why clover and timothy may not supply the place of the English "seeds" in the rotation adopted here; the former giving abundant crops usually for two years, and the latter continuing so long as the ground is kept top dressed, unless improved by close cutting or feeding.

RAIN.—It is a common mistake to suppose that the rain-fall of England is greater than that of the United States. Recent observations in this country enable us to make the comparisons between the fall of rain in the two countries with considerable accuracy, not only as to the amount which descends annually, but, what is more important, as to the amount in each particular season of the year. The average rain-fall of England is, in general, much less than that of the United States. In the eastern portion of England the annual fall of rain is estimated at twenty inches; in the middle portion, at twenty-two inches; in the southern and western, at thirty; in the extreme southwestern, at forty-five inches. In Wales it is estimated at fifty inches; in the eastern portion of Ireland, at twenty-five inches, and in the western at forty inches.

The rain-fall in the United States, as shown by Blodgett's rain chart, is in the basin of the great lakes, 30 inches; on Lake Erie and Lake Champlain, 32 inches; in the valley of the Hudson, on the headwaters of the Ohio, through the middle portions of Pennsylvania and Virginia, and western part of North Carolina, 36 inches; in the extreme eastern and the northern portion of Maine, northern portions of New Hampshire and Vermont, southeastern counties of Massachusetts, central New York, northeast portion of Pennsylvania, southeast portion of New Jersey and Delaware, also on a narrow belt running down from the western portion of Maryland, through Virginia and North Carolina, to the northwestern portion of South Carolina, thence up through the western portion of Virginia, northeast portion of Ohio, northern Indiana and Illinois, to Prairie du Chien, 40 inches; on the east coast of Maine, eastern Massachusetts, Rhode Island, and Connecticut, and middle portion of Maryland, thence on a narrow belt to South Carolina, thence up through eastern Tennessee, central Ohio, Indiana, and Illinois, to Iowa, 42 inches, and the same down through western Missouri and Texas to the Gulf of Mexico; from Concord, New Hampshire, through Worcester, Massachusetts, western Connecticut and the city of New York, to the Susquehanna river, also at Richmond, Virginia, Raleigh, N. C., Augusta, Ga., Knoxville, Tenn., Indianapolis, Ind., Springfield, Ill., St. Louis, Mo., thence through western Arkansas, across Red river to the Gulf of Mobile, 45 inches; from the belt just described, the rain-fall increases inland and southward until at Mobile it is 63 inches; the same amount also falls in the extreme southern portion of Florida.

The rain-fall of New England, it is perceived, is about double that of the eastern and middle portions of England. Observations at London, by Dalton, for forty years gave an average fall of 20.69 inches, while observations for forty-three years at New Bedford, Mass., gave 41.03.

The most striking difference as to the fall of rain in the two countries is found in the quantities which fall in single days. While we have vastly more rain in our country, we have far less rainy days. In the United States we have either decided rain, or bright, fair weather; while in England, though it seldom rains hard, there is half the time a fog or a drizzle.

Observations at Oxford, in England, in 1854, show that rain fell there on one hundred and fifty-six days. Seventy-three of those days gave each less than one-twentieth of an inch, while one day gave as much as one inch!

In the same year, by the tables of Dr. Hobbs, of Waltham, Mass., it appears that rain fell on but fifty-four days, on no one of which was there less than one-twentieth of an inch, and more than one-fourth of the number gave more than one inch, and three days gave each between two and three inches!

One inch of rain in twenty-four hours is regarded as a heavy fall in the south of England, while in New England a fall of three or four times that quantity is not unusual. About fifty rainy days may be taken as the average in New England, while Old England has three times that number, with a liberal quantity of fogs and mists thrown into the bargain.

In the growing season, the observations of Dr. Hobbs show the average fall of rain in Waltham, Mass., for a period of 35 years, to be as follows:

April, 3.96 ; May, 3.71 ; June, 3.18 ; July, 3.38 ; August, 4.50 ; September, 3.52.

The quantity of rain falling in each month, as registered at the observatory in Cambridge, Mass., is as follows:

Mean of observations for twelve years: January, 2 .39 ; February, 3.19 ; March, 3.47 ; April, 3.64 ; May, 3.74 ; June, 3.13 ; July, 2.57 ; August, 5.47 ; September, 4.27 ; October, 3.73 ; November, 4.57 ; December, 4.31.

Spring, 10.85 ; Summer, 11.17 ; Autumn, 12.59 ; Winter, 9.89.

Average quantity per year, 44.48.

The absolute quantity of rain, and the rapidity of its fall, have a material bearing upon all the mechanical operations of the farmer. The necessity of drainage depends both upon the quantity of water to be conducted through the soil, and upon the rapidity with which it is to be disposed of.

The opinion has often been expressed, that, however much drainage may be necessary in England, it is far less important here, because England has a wet and the United States a dry climate. We have already seen that far more rain falls here than there, and that it falls with far more violence. Hence, upon soils of the same character, we have, in fact, far more occasion for drainage than England. It is true that another element is to be considered in discussing this question, namely : Evaporation.

In our hot and clear summer days evaporation proceeds with far more rapidity than under the cloudy skies of Great Britain. Yet it is to be remembered that in the warm season, in neither country, is there much flow of water from drains laid in what may be termed high land. The chief occasion for drainage on such land is to secure a discharge of stagnant water, and to admit the passage through the soil of the great rains of the spring.

In New England, where the ground is locked up by frost until nearly planting time, and where large bodies of snow are dissolved in a few days, not only is drainage important, but it is necessary that pipes used in the process should be of greater capacity than in England, because we have a vastly larger quantity of water to pass off in a given time. Without regard to the fact that evaporation is a cooling process, and so is, in the spring, injurious to vegetation, it is an agency entirely inadequate to free our lands from the vast amount of rain that falls upon it. The whole evaporation in the year from a land surface in Massachusetts is estimated at twenty inches, or less than half the rain-fall, leaving a like amount, at least, to drain off by filtration or by running from the surface. It is true, however, that in a porous soil even the large rain-fall of our country may pass off without injury by percolation through the soil, and, as has been before suggested, that there is a large proportion of our lands which would not be sufficiently improved by drainage to justify the expense of the operation.

The annual amount of rain in the two countries is, manifestly, not the circumstance which controls their products respectively. Although this is an element important to be considered, yet the tropical heat of our summers gives us Indian corn and other plants which cannot grow in England, while, as we have seen, the absence of severe frosts and snows in England, and a longer season for vegetation, and cloudy and dripping skies in summer, give them, in general, a better grazing country ; the turnip crop to be fed off by their sheep, a shorter winter for house-feeding their animals, and a more convenient opportunity for performing, without undue haste, the necessary processes of cultivation.

III. COMPARISON OF ENGLISH AND FRENCH AGRICULTURE.

ENGLAND PRODUCES DOUBLE IN QUANTITY AND THREE TIMES IN VALUE PER ACRE.—COMPARISON OF SOIL AND CLIMATE.—SUBDIVISION OF LAND.—MANAGEMENT OF CATTLE AND SHEEP BETTER IN ENGLAND.—VARIETY OF FRENCH PRODUCTS, BEET-ROOT, WINE, ETC.—CAPITAL AND SKILL ACCOUNT FOR ENGLISH SUPERIORITY.

In no other way is improvement so likely to be made in Agriculture as by a careful observation of its results under different circumstances and a critical examination of the means by which those results are obtained. The main object of all agriculture may be said to be the production of the greatest amount of human food upon a given portion of the earth's surface with the smallest expenditure of labor and of manure, or other material of value for other uses. This object of producing food for man may be attained directly by the culture of bread and fruit crops, or by the production of crops for the sustenance of animals which contribute to man's support.

Lavergne, in his Rural Economy of France and Britain, published in 1854, institutes an interesting comparison between the productiveness of the two countries, and undertakes to give the reasons for the vast superiority of the British over the French husbandry. Being

himself a Frenchman and a man of education, and having at one time filled the chair of Rural Economy in the Agronomical Institute at Versailles, his frank admissions of England's pre-eminence may be regarded as entirely reliable, and his exposition of the reasons of it as entitled to great respect. Those reasons being such as may probably affect alike the agriculture of America and France may find an appropriate place in our investigations.

The average production of wheat in France is set down at 13½ bushels to the acre, while in England it is about 28 bushels to the acre. Lavergne says, if we add to this estimate as to wheat the maize, buckwheat, and rye of France, crops there cultivated to a considerable extent, and little cultivated in England, and compare the average of the four grain crops with the wheat crop of England, we shall find the production in England more than double in quantity, and in money value three times as much.

Again he says: France, taken as a whole, produces annually $8 per acre, and England proper produces $16. The *animal* produce of an English farm is equal, at least, to the *total* produce of a French farm of equal area, all the vegetable production being additional. By the census of 1841 the total population of the United Kingdom of Great Britain was 27,000,000, and that of France 34,000,000; and comparing the extent of the two countries, it is found that while England maintained nearly one person on each 2½ acres, France maintained only one on each 3¾ acres.

With respect to the value of land, which is usually estimated by its productiveness, the estimate value for England proper is $160 per acre, while that of France is put at $80 per acre. Taken as a whole, the product of British agriculture may be estimated, in comparison with that of France, *over an equal surface*, as 135 to 100, or 35 per cent. greater; and if we compare England *alone* with the whole of France, the former produces at least twice as much as the latter on every acre.

England proper contains about thirty-two and a half millions of acres, or about one-fourth the area of France; yet Mr. Lavergne admits that France does not possess thirty-two and a half millions of acres equal in cultivation to the area of England.

In comparing England with America, we are fond of making large allowance for the fact that ours is a new country, where system has not had time to develop—where land is cheap and labor dear—and are too ready to rest satisfied that time only is necessary to bring up our average products to something like those of England, or, at least, to console ourselves with the idea that, although our average products of wheat is less than one-third that of England, the fault is rather that of our circumstances than of ourselves. When, however, we see France, an old country, the ancient rival of England in all the arts, both of war and peace, her nearest neighbor, with but two hours of water passage between, falling so far below her in the matter of agricultural productiveness, which is the very test of the resources and wealth of a nation, we look with great interest for the causes or occasions of the difference.

The natural solution of the problem we should expect to find in the excellence of the soil and climate of England. But facts do not warrant this solution. Some of the most fertile counties of England, such as Lincoln, were formerly barren wastes or mere fens and marshes; and the sheep-husbandry of England, with its four-course system, which is the secret of her prosperity, originated from the sandy soils and bleak atmosphere of Norfolk. We give from Lavergne, in his own language, upon these points:

"British agriculturists have known well how to avail themselves of the peculiarities in their climate, for, in itself, there is nothing very seductive about it. Its mists and rains are proverbial; its humidity is little favorable to wheat, which is the prime object of all cultivation; few plants ripen naturally under its dull sky; it is propitious only to grasses and roots. Rainy summers, late autumns, and mild winters encourage, under the influence of an almost equal temperature, an evergreen vegetation. Here its action stops; nothing need be asked of it which demands the intervention of that great producing power, the sun.

"How superior are the soil and climate of France. In comparing with England, not the fourth only, but the northwest half of our territory, that is to say, the thirty-six departments grouped about Paris, exclusive of Brittany, we find more than twenty-two millions of hectares (55,000,000 acres) which surpass in quality, as they do in extent, the 13,000,000 hectares (32,500,000 acres) of England. Scarcely any mountains; few natural marshes; extensive plains sowed almost throughout; a soil sufficiently deep, and of a nature most favorable to production; rich deposits in the broad valleys of the Loire and Seine, with their tributaries; a climate not so moist but warmer, less favorable, perhaps, to meadow vegetation, but more suitable for ripening wheat and other cereals; *all the productions of England obtained with less trouble;* and, in addition, other valuable products, such as sugar, textile, and oleaginous plants, tobacco, wine, fruits, &c."

Arthur Young, the celebrated English agriculturist, in 1789, after his agricultural tour in France, bears similar testimony. He pronounced France to be superior to England in soil and in climate, but, he says, "We know how to turn our climate to the best account, and the French, in this respect, are still in their infancy."

The division of territory into small farms in France is usually regarded by Englishmen as a reason for the inferior productiveness of her soil to that of England. By the laws of France all children inherit equally the real estate of the parent, who has not the power to direct it otherwise, even by will, while in England all the land descends to the eldest son, unless otherwise devised. The tendency, therefore, in France is to constant subdivision, and the result of this is plainly visible, in travelling through that country, in the narrow strips into which the fields are divided by alternate crops, giving the appearance of market gardens, rather than of the broad wheat and turnip fields of England. The effect of large and small estates upon productiveness is fairly and temperately discussed by Lavergne, and we confess that his statements have materially modified our ideas as to the difference in the accumulation of lands in the two countries. He says that the fact of subdivision in France is much exaggerated, and that there are now in France 1,000,000 landed proprietors who pay upwards of $60 direct taxes, and whose fortunes average those of the mass of the English proprietors. Estates of 2,500 to 5,000 acres are frequently to be met with, and landed fortunes of from five to twenty thousand dollars and upwards of annual *rent* are not unknown. Still the general fact remains, that English farms are held in larger tracts, and that many English farms are owned by single proprietors. In another place we have endeavored fairly to consider the operation of these large holdings upon productiveness. It is sufficient here to say that we cannot find in this fact of subdivision alone a reason for the inferior productiveness of France.

There can be no doubt that the political and social condition of England for two or three generations has been more favorable to the culture of the soil than that of France. For that period the English farmer has quietly pursued his labors, scarcely disturbed by wars, or the rumors of wars, which his country might be waging abroad, while France has been convulsed by revolutions, and her soil wrested from its owners and divided anew.

These causes have operated to depress agriculture, not so much by the legitimate effect of any peculiar system of tenure as by distracting attention from agricultural pursuits, and bringing into them a new class unacquainted with their business.

The question, "Why is English agriculture so much more productive than French agriculture?" is frankly attributed by Lavergne to the *superior cultivation* of Great Britain. English farmers prosper and raise larger crops and better animals than France because they understand their business better, not because they have a better soil, a better climate, or more just laws, except so far as these laws secure to them the quiet pursuit of their husbandry.

The practical inquiry then arises for us, who would profit by this investigation, In what particulars are English principles of husbandry superior, or English processes productive of better results? A hasty journey through France gave little opportunity for personal examination, but our own observation and such information as we have been able to obtain from the author already quoted and other sources seem clearly to indicate that the errors of the French are, in many respects, nearly allied to our own. They, as a radical error, cultivate too much land, or rather they crop more land than they cultivate thoroughly. Although labor is somewhat cheaper in France than in England, we have seen that two acres there produce less than one acre in England; whereas, having a better soil and climate, France, with equal cultivation, should produce the larger crop to the acre. Lavergne says that the facts developed by him "verify this agricultural law, that, to reap largely of cereals, it is better to reduce than to extend the breadth of land sown, and that by giving the greatest space to the forage crops, not only is a greater quantity of butcher meat, milk, and wool obtained, but a larger production of corn also. France will achieve similar results when she has covered her immense fallows with root and forage crops, and reduced the breadth of her cereals." Like Americans, the French seem to regard more the crop desired for immediate use than the condition of the land when cropped, while the English will not sacrifice their compensating system, which leaves the land in high condition for succeeding crops, to any desire for immediate and large returns. The French farmer takes his crop of wheat, of rye, of buckwheat, with a fallow, perhaps, between, while the English farmer spends one year to produce turnips and another year to produce "seeds,"—neither of which crops bring him a dollar directly—that he may, in the four-year rotation, raise a crop of wheat and a crop of barley large enough to repay all his labor and expense and not impoverish his soil.

Again: in cattle and sheep husbandry far more careful attention has been bestowed in England than in France upon both the breeds and treatment. The French breed sheep, as do the Americans, rather for wool than for mutton. The improved Leicesters of England attain maturity and nearly double weight at one-half the age of French sheep. The average of French wool does not exceed in value the average price per pound of English wool, though the merinos of some flocks yield better wool than any English sheep. England proper supports, on the same area, three times as many sheep as France. "England," says Lavergne, "feeds two sheep per hectare, ($2\frac{1}{2}$ acres,) whilst the average of France is only two-thirds of

a head; and the produce of the English sheep being, besides, double that of the French, it follows that the average return of one English sheep-farm is *six times* greater than a French one." In our remarks upon sheep-husbandry in England we have given the results of the English methods of treatment. In France, at the present time, about one-half the sheep are supposed to be merinos, or half-breed merinos, confessedly unprofitable as mutton sheep; and we think it evident that, however profitable the breeding of fine-wooled sheep may be on the prairies of the West and Texas, or the cheap lands of Australia, they cannot be kept with advantage on the high-priced lands of France. The flesh and wool of a one or two-year old sheep of 100 lbs. weight is a more profitable growth than the finer but lighter fleece of the merino, and a comparatively worthless carcass at five or six years old.

A comparison of the cattle-breeding of France and England presents a contrast fully as striking in favor of the latter country as that observed in sheep-breeding. France was estimated in 1856 to contain ten millions of cattle—somewhat more in number than Great Britain and Ireland—yet an investigation will clearly show that the profit of cattle-growing in England alone on half the number of head which France possesses is greater than all the profits of France from her cattle. Cattle are valuable in four ways—for their meat, their labor, their milk, and their manure. In France, as in America, oxen are much used for their labor; in England, although used to a limited extent in some counties, this is the exception, and not the rule. In general, the ox in England is a creature of leisure and dignity, pampered from his birth with all the good things of life that can conduce to his comfort and growth, and never subjected to the yoke. He lays on the greatest possible amount of flesh, consuming the greatest possible quantity of the best food, and converting it into the richest manure, which is carefully saved and highly valued. As soon, however, as he has attained his greatest weight, and so has ceased to make a return in the way of meat, his career is ended by the butcher, and his account of profit and loss is closed. In France, as in New England, the first use of the bullock is for farm labor. He is expected to work for his living, and to pay his board as he goes along—to work his passage through life, and not to be borne along "on downy beds of ease." If he can grow under the treatment so much the better, but work he must. If his manure can be saved, very well; but saved or not, he must work. When he has arrived at a good old age, and cannot work to advantage, then he is comforted with good pasture and stall feed, and converted into beef. French beef, but not the "roast beef of Old England." The mode of working cattle in France is in some parts in yokes like our own, but often in the mode observed on the continent by a yoke or straight piece of timber laid across their foreheads and strapped to their horns, the cattle being in pairs, and the tongue of the cart or the chain being attached much in the same manner as with us.

In Switzerland and the South of France we often observed oxen in both ways in adjoining fields. We had supposed that in this mode of harnessing it would be impossible for cattle to perform labor to any great amount, but on careful observation we could perceive no difference in favor of yokes and bows. In drawing by the head the cattle hold their heads nearly in a line with their backs, and of course keeping them perfectly steady; they seemed to do their work with as much comfort, and to carry as heavy loads as cattle of the same weight in the ordinary yoke. It may be said here, however, that nowhere in Europe have we ever seen so fine oxen in the yoke as we daily see upon New England farms.

The question of the profit of working cattle has great interest for us, and is one much discussed in New England. While it is contended on the one hand that in new and rough lands the slow and heavy gait of oxen is more suitable than the quicker pace of horses or mules, on the other it is asserted that horses and mules may be substituted for oxen even in bogging swamps, and are infinitely superior in all old fields. Mr. Lavergne declares that "the working of horned cattle, whether necessary or not, entails a loss, instead of being profitable."

Again, the French, like the Americans, kill many of their calves for veal, while in England veal is regarded as both unprofitable and undesirable for food. Veal is of far better quality in France than in America, because the calves are kept until three or four months old in France, while we kill them at the age of four or five weeks.

The effect of keeping calves, as in France, for veal is seen in the amount of dairy produce in the two countries. Lavergne estimates the number of cows in France at four millions, and those in Great Britain and Ireland at three millions. One-half of all the milk in France is supposed to be consumed by the calves, while but one-third of the milk is thus consumed in England. The reason of this seems to be, that to keep calves three months for veal of the finest quality requires a large supply of new milk, while calves to be reared for bullocks are taken early from the cows and fed on less expensive food. Mr. Lavergne estimates the dairy produce of Great Britain, with three-fourths the number of cows, at *four times* the value of the dairy produce of France. Returning to our general estimates as to cattle in the two countries, we find that in the British Isles the number of cattle annually slaughtered is two millions, averaging great and small, about 550 lbs. weight of meat each.

In France the number annually slaughtered is four millions, averaging, in meat, about 220 lbs. each; the English cattle, with two millions of head, producing about 1,100,000,000 lbs. of meat, and the French cattle, with double the number of head, producing but about 880,000,000 lbs., or 220,000,000 less than the English.

This singular disproportion is explained chiefly by the difference in the age of the animals slaughtered. "The French cattle," says Lavergne, "are slaughtered either too soon or too late. The paramount necessity of keeping cattle intended for labor obliges us to kill a great number of calves at the age when growth is most rapid; those that survive are not slaughtered until an age when growth has long ceased; that is to say, after the animal has for several years continued to consume food which has not served to increase its weight. The English, on the contrary, kill their animals neither so young, because it is, when young, that they lay on flesh most rapidly, nor so old, because then they have ceased to increase. They seize the precise period when the animal has reached its maximum growth."

Upon the whole, a comparison of French and English agriculture indicates that on a much larger area France sustains scarcely a larger number of head of cattle and sheep than the British Isles, and that, considering the rapidity of growth and early maturity and superior weight of British animals, the animal produce of England is far greater. A larger production of land in France is under crops for immediate human food, but with far less product per acre. The rotation of crops being imperfectly understood, nearly one-eighth of her arable land is left fallow each year. A far less breadth of soil is devoted in France to the cultivation of green crops for animals; a far less amount of manure, consequently, is saved to be applied to the cereal crops. In short, in England the four-year course of husbandry, although recently attacked by Liebig as exhausting in theory, and as he contends to prove so in fact, seems yet to be compensating and self-sustaining; while in France no system seems to be fully understood, and the result of individual experiment there, as elsewhere, is general failure to find what is best in the long run. In France, as in America, there is a want of the large capital and systematic effort so productive of grand results in England. Indeed, we can hardly institute a comparison between the agriculture of England and that of any other nation without illustrating, at the same time, the superiority of British agriculture, and the fact that we, too, in America are deficient in the points with the other nations.

Many have attributed the disparity between the productiveness of England and France to the greater variety of French products. There is doubtless truth in the common idea that he who undertakes to do many things will do none of them well; and the fact that the variety of French products requires variety of knowledge in the producers, while the English system is plain and simple, may account, in some measure, for the greater apparent skill of the English farmer. M. Lavergne, however, seems to regard this variety of products as a source of wealth to France, which partly redeems her inferiority to England.

The vineyards of France cover about five millions of acres of land, a great portion of which is unfit for cereal crops, and the average product per acre is estimated at twenty dollars, giving an annual value of one hundred millions of dollars. The blight upon the grape in 1854 and 1855 destroyed half the crop, and brought great distress upon some of the rural districts. An attempt has been made to supply the deficiency of spirits which have been usually distilled from wines, by distilling them from beet-root.

The extent of land under cultivation in beets, principally used for the manufacture of sugar, is computed at 125,000 acres. After the extraction of the saccharine matter, the residue is used for the feeding of cattle, and so is probably made a profitable crop, though it is believed that the culture of beets for the sugar alone is not remunerative.

The colza, or rape, for the manufacture of oil, also occupies a somewhat prominent place in France, about two and a half millions of acres of land being devoted to it, of a quality suitable for wheat.

Tobacco, madder, the olive and mulberry, are also products of France, and it is estimated that two and a half millions of acres of gardens and orchards are also cultivated in the kingdom. English agriculturists maintain that this variety of crops is not beneficial to a country, and that its interference with a systematic and well-established rotation more than balances any profit derived from it.

Thus have we endeavored to present the prominent points of difference in the agriculture of these two countries. It seems to be claimed by England, and admitted by French writers, that England, with inferior soil and climate, produces at least double the crops of cereals per acre, and far more profitable breeds of sheep and cattle, while the various products of France, which cannot endure the chills of English fogs, by no means compensate for French deficiency in the great staples of corn and meat. The secret of English superiority over French agriculture, and, indeed, over that of any other nation, may, we think, be found in two words CAPITAL and SKILL.

IRRIGATION.*

BY E. GOODRICH SMITH, WASHINGTON, D. C.

That water exercises a most important influence in the process of vegetation is a truth of such general reception that few, perhaps no one, will be found ready to deny it. The contrasts between a dry and barren region and a richly-watered land are too marked to admit of dispute. Truths, however, which are so common as to be universally acknowledged are sometimes the least pondered; and ages need to pass before the full benefits of many a practical principle are wrought out into earnest efforts of application as they can be by the enlarged development of their true bearings on the welfare of mankind. This remark may be broadly referred to the subject of IRRIGATION.

From the earliest dawn of primeval history, in the opening records of the life of man on earth, it is recognized. Ever since, water, in some use of it, has been applied in the cultivation of the soil; but what great ends may be answered by more careful efforts to render its power available in the growth and production of herbage and fruits of the ground is as yet among the resources of husbandry comparatively little thought of or cared for.

In this country, especially, hardly anything is yet known of its agricultural capabilities. With the exception of interval lands, or natural meadows, and the rice-grounds of the Southern States, the means it affords of enriching soils and promoting the growth of vegetation is almost an unbroached topic. And yet this very season, and for many months, we have accounts in the public journals of whole large tracts of land in some of our States suffering unexampled drought, the cattle dying, and the people almost in a state of starvation, for want of rain. If not all, much, no doubt, of this misery might have been avoided by an early and thorough attention to irrigation, by which the natural supply of the rivers and streams could have been led out and thrown over the soil, or so husbanded as to be ready for use when the clouds gave no rain, and the pastures were beginning to languish for such sustenance.

It is proposed, in the present essay, to furnish some information on the main points of the History and Progress of Irrigation; and, so far as the means and space at command will permit, to state the most approved methods of conducting it, with their results.

The earliest records of all nations, the poetical imagery of every people living, far back in the gray dawn of antiquity, indicate no mean appreciation of the influence of their larger or smaller streams on the success of their tillage or grazing. No more beautiful description of this kind can perhaps be found than the picture drawn by a Hebrew poet when he speaks of the provision God has made for the people of those Eastern climes: "He sendeth the springs into the valleys which run among the hills;" "He watereth the hills from his chambers;" and the laughing abundance by which the months are crowned in consequence of it: "The little hills rejoice on every side. The pastures are clothed with flocks; the valleys also are covered over with corn; they shout for joy: they also sing."

The cradle of the human race and their first settlements being in Eastern climes, where the temperature is usually more hot and dry than with us, the care of the first tillers of the soil, as well as of the more numerous class who, with the nomadic habits handed down to them from a distance, were devoted to pastoral life, was directed to securing that supply of water for their fields which might yield food to their families, flocks, and herds. For this purpose, in case the natural supply was scanty, they dug wells and canals, and sought to lead out streams and rivulets to spread over their lands as widely as possible the benefits of the collected water. It was the well-watered plain of Jordan on which the eye of the observing and eager Lot was fixed when his patriarch uncle gave him his choice of all the country lying before him, because there his numerous flocks could find a rich and unfailing pasture ground.

To guard against the effect of heat in drying up the fields was an object of great desire. Artificial means of various kinds were adopted. Among the ancient Assyrians, Babylonians, and Egyptians a variety of such methods were resorted to for this purpose. Herodotus mentions the fact that, though the rivers in Assyria overflowed their banks, as in Egypt, yet the

* In the preparation of this article free use has been made of the varied sources of information at hand; and as sometimes the extracts, translated or otherwise, have been given only partially in the exact words of the authors, and also interwoven with other matter, a general acknowledgment here is deemed sufficient. Thaer, Koppe, Schwerz, Fraas, Von Lengerke, Hlubek, and other German authors, the different agricultural journals, encyclopedias, and treatises on husbandry in German, French and English, have been examined, and whatever was deemed useful appropriated.

effect of such a natural inundation was not, like that of the Nile, sufficiently charged with fertility; and the Assyrians had recourse to artificial means for the purpose of watering their fields and gardens. Canals were constructed, at great expense, and sometimes lakes and large reservoirs were prepared, by means of which the natural deficiencies might be remedied. Even in modern times travellers speak of the remains or evident traces of structures as still in existence, which indicate on how large a scale such aids to the agriculture of these ancient people must have been conducted.

The unchanging nature of the customs and arts among the Eastern nations for centuries and thousands of years renders this testimony more distinct and applicable. Sir Henry Rawlinson, in the Notes to Rawlinson's Herodotus, says: "Rain is very rare in Babylon during the summer months, and productiveness depends entirely on irrigation." "At the present day it is not usual to trust even the first sprouting of corn to nature. The lands are laid under water for a few days before the corn [the general expression for all the cereals] is sown; the water is then withdrawn, and the seed scattered upon the moistened soil."

Mr. Layard, in his Researches in Assyria, after alluding to the artificial canals derived from the Tigris and Euphrates, designed for the purposes of irrigation, and which intersect the lower part of Mesopotamia, remarks: "The Assyrians also used machines for raising water from the river or from the canals when it could not be led into the fields through common conduits. They were generally obliged to have recourse to this artificial mode of irrigation, as the banks of the rivers, and consequently those of the canals, were high above the level of the water, except during the spring. At that season of the year the streams, swollen by the melting of the snow on the Armenian hills, or by violent rains, overflowed their beds." He states, too, that the same practice, no doubt handed down from time immemorial, still prevails. Speaking of the people who came to him while he was engaged in his excavations at Nimroud, he says: "They already began to prepare water-courses and machines for irrigation. The mode of raising the water generally adopted in the country traversed by the rivers of Mesopotamia is very simple. In the first place, a high bank, which is never completely deserted by the river, must be chosen. A broad recess, down to the water's edge, is then cut into it. Above, on the edge of this recess, are fixed three or four upright poles, according to the number of oxen to be employed, united at the top by rollers running on a swivel, and supported by a large framework of boughs and grass extending to some distance behind, and intended as a shelter from the sun during the hot days of summer. Over each roller are passed two ropes, the one being fastened to the mouth, and the other to the opposite end of a sack formed out of an entire bullock skin. These ropes are attached to oxen, who throw all their weight upon them by descending an inclined plane cut in the ground behind the apparatus. A trough formed of wood and lined with bitumen, or a shallow trench coated with matting, is constructed at the bottom of the poles, and leads to the canal running into the field. When the sack is drawn up to the roller, the ox turns round at the bottom of the inclined plane, and, the rope attached to the lower part of the bucket being fastened to the back part of the animal, he raises the bottom of the sack in turning to the level of the roller, and the contents are poured into the troughs. As the ox ascends the bucket is lowered; and when filled by being immersed into the stream, is again raised and emptied, as I have described. Although this mode of irrigation is very toilsome, and requires the constant labor of several men and animals, it is generally adopted on the banks of the Tigris and Euphrates. In this way all the gardens of Baghdad and Busrah are watered, and by these means the Arabs who condescend to cultivate—when, from the failure of the crops, famine is staring them in the face—raise a little millet to supply their immediate wants."

Herodotus refers to a machine or mode of raising water for purposes of irrigation, on which Colonel Rawlinson observes that this engine mentioned by Herodotus seems to have been the common handswipe, to which alone the word he uses would properly apply. Representations of the handswipe have been found on the monuments in Assyria. Colonel McChesney also describes a similar process which he noticed in his route along the Euphrates and Tigris, and states that, when the bank is too high to throw up the water with a basket, it is raised by another process equally simple. "A wooden lever, from thirteen to fifteen feet long, is made to revolve freely on the top of a post three or four feet high, projecting about two-thirds the length of the lever over the river, with a leather basket suspended from the extremity; this is balanced, when full of water, by means of a basket of earth or stones at the other end; and this machine is so well contrived that only slight manual exertion will raise the basket sufficiently high to empty its contents into a cistern or other kind of receptacle, from whence it is dispersed over the fields by means of numerous small channels." This contrivance is almost identical with the well-sweep and bucket which used to be common in parts of our own country for raising water from wells. There appears to be a general similarity all through Western Asia, as well as in Egypt, in the modes resorted to for the purposes of irrigation. The pictured representations on the tablets in the tombs of Egypt correspond to what is now in constant use in that and other countries. The mode of

raising water just described is scarcely different from that which is called the *shadoof*, still resorted to for watering fields. From the delineations on the Egyptian monuments it is evident that water-pots full of water, swung by a yoke from the shoulders of men, were extensively used in irrigation. Allusions to this method are not unfrequent in the Scriptures. Another way, still seen, is by what is called the *ckutweh*. A cut or indentation is made in the bank of the river, into which the water flows as a sort of reservoir. Men stand on opposite sides of this trench, and by means of a wide, bowl-shaped bucket, (the *ckutweh*,) to which are fastened ropes, dipping it till filled, raise it, and so discharge the water on the bank. A multiplication or series of shadoofs, too, in a kind of terrace, one above another, is frequent where the river is low, or its banks too high for shadoofs on the same level to raise the water to the surface of the soil. The water is thus raised from the river and discharged into a trench, from which it is taken by other shadoofs and discharged into another trench above; and so on, from one trench to another, until it is brought up to the level of the fields.

Yet another machine, (the *sackiyeh*,) called the Persian wheel, is very common, and the principal one employed in the irrigation of gardens. Mr. Lane, in his Modern Egypt, gives a description of this apparatus. He tells us that "it mainly consists of a vertical wheel, which raises the water in earthen pots attached to cords and forming a continuous series; a second vertical wheel fixed to the same axis; and a large horizontal cogged wheel which, being turned by a pair of cows or bulls, or by a single beast, puts in motion the two former wheels and the pots." The revolution of the wheels takes down the string of buckets on one side, raising them on the other filled with water. When they reach the top they turn over, discharge their contents into a trough, and again descend; and so on continuously. The trough leads to a reservoir, and thence the water is distributed in little streams or rills over the field or garden. A machine somewhat different, called a *taboot*, instead of buckets, has places hollowed out in the felloes, which dip in, take up the water, and discharge it when raised. This, however, answers only when it is necessary to raise the water but a few feet. "Grounds requiring to be artificially watered are divided into squares by ridges of earth or furrows; and the water flowing from a machine or cistern, by a narrow gutter, is admitted into one square or furrow after another by the gardener, who is always ready, as occasion requires, to stop and divert the torrent by turning the earth against it with his foot, and opening at the same time with his mattock a new trench to receive it." A similar method may be referred to in the Sacred Scriptures, where allusion is made, in the eleventh chapter of Deuteronomy, to Egypt as a land watered by the feet.

The effect of the spread of the waters of the Nile over the surrounding region of country is well known. A strip of land bordering on the river lies between the deserts on either side, not exceeding some twelve or fifteen miles in width, and sometimes narrower; and the whole of Egypt is dependent on the productiveness of its soil gained from the annual inundation of the river. From the descriptions which have come down to us from antiquity, the utmost care was taken by the inhabitants accurately to mark the time and amount of the flow, and, when the period had come, to treasure up its fertilizing power by every resource at their command, so that none of it might be wasted. It no doubt exhibits the same features in its effect on vegetation now as it did then, and an account of it may therefore be borrowed from a modern source which will answer for all times:

"The Nile shows the first signs of rising in Egypt about the time of the summer solstice. At Khartoom, where the White river and the Blue river join, the commencement is observed early in April. The slowness of the rise at first causes this difference. Usually the regular increase does not commence in Egypt until some days after the summer solstice. The river attains its greatest height at or not long after the autumnal equinox, and then, falling more slowly than it had done, it remains stationary for a few days, until it begins again to increase. The inundation continues rather longer than it naturally would, because the waters are retained for some time upon the lands by closing the mouths of the canals. The river's banks being a little higher than the rest of the cultivable soil, the water is conveyed by canals or cuttings, and does not pour over the banks. The inundations vary considerably, and either by failing or rising to too great a height cause much damage and distress." A table is mentioned of sixty-six inundations, from 1737 to 1800 continuously included, of which 11 were very high, 30 good, 16 feeble, and 9 insufficient.

The Nile rises about forty feet at the first cataract, about thirty-six feet at Thebes, twenty-five at Cairo, and about four feet at the Rosetta and Damietta mouths, during a good inundation.

"It will thus be seen that the inundation decreases greatly as the river descends towards its mouth. In speaking of its having attained a certain height usually, reference is had to its height at Cairo, and with but a slight difference of the respective heights at Memphis, by the old writers. If the river does not reach higher than eighteen or twenty feet, the rise is a scanty one; if two or four feet more, insufficient; but if it rises to twenty-four feet or a greater height, not above twenty-seven feet, then the inundation is said to be good; but

if it exceeds twenty-seven feet, it is destructive, as in such case it is followed by the plague and murrain."

The current of the Nile at the lowest is estimated at about two feet per second, or one and one-third mile in an hour, and at about three miles when at the height. The volume of water it pours into the Mediterranean in twenty-four hours is, during the low Nile, 150,566,392,368 cubic meters, (a cubic meter being 35,317 cubic feet,) and during the high Nile, 705,514,667,440 cubic meters—there being thus a difference of 554,948,275,072 cubic meters. Charged, as it is, with alluvial matter, yet it is stated that the deposit left in a century on the land—and so the annual deposit—is much less than might be supposed. The ordinary average increase of the soil of Egypt, one century with another, may be regarded as 4½ inches only. Somewhat more than two-thirds of the whole space included between the two deserts is only about 6,921 square miles, comprising the land which is or can be brought under cultivation; but the space actually cultivated does not exceed 5,500 square miles. Yet all this is absolutely dependent on the natural or artificial irrigation from the Nile, for rain is unknown. Egypt was anciently called the granary of the world; and from it the whole Roman empire drew large supplies of food. There could be no more decisive example of the importance of irrigation than is furnished by these facts; and that for thousands of years, without rain, without moisture, except as thus brought upon the land, it has, as if inexhaustible, poured forth the riches of its abundance of wheat to feed needy and not rarely starving nations. Stern necessity taught the people, long ages ago, to make the most of the means at their hand, and, with the monuments of their grandeur, the proof is found of their wisdom in adapting their means to the end.

Throughout Persia and Syria, and all the more Eastern countries, irrigation is still practiced at the present day. In China and India, as is well known, it has had an important place among the agricultural practices of those nations, and dates back to a very high antiquity. The same is true of other countries in Africa besides Egypt. Rude methods of various kinds show how universal is the conviction of its necessity in some form as an aid to the cultivation of the earth and the raising of crops. Some of the methods in these different countries at the present time will be again adverted to. They are mentioned here as proof of universal prevalence and transmission from former ages.

On this Western continent, in ancient Peru, the Spaniards found the most costly works for irrigating lands. Prescott says: "Canals and aqueducts were seen crossing the lowlands in all directions, and spreading over the country like a vast network, diffusing fertility and beauty around them." The Aztecs of Mexico also made use of irrigation; and the Spaniards on their arrival in that country were astonished at the perfection to which horticulture was thus carried.

Few of the works of authors on agriculture among the ancient Romans have reached us; but, in the pages of such authors as have survived the general loss, we have evidence that the subject of irrigation was of interest to that truly practical people. M. P. Cato, the earliest of these writers on Roman agriculture, (150 years before Christ,) recommends to his countrymen to form water-meadows if they have water. Columella is explicit in his directions. He says, in his second book, chapter 16: "Land that is naturally rich and in good heart does not need to have water set over it;" and, after mentioning that the hay which nature produces of its own accord in a juicy soil is better than that which is procured from a soil overflown by water, he adds: "This practice, however, is necessary when the poorness of the soil demands it, and a meadow may be formed either on a stiff soil or on a porous one, and though it is poor when water is brought upon it. Yet neither a low field full of hollows, nor one with steep rising ground, is suitable for such a purpose; as the former retains the water too long in the hollows, and because the water runs over too quickly." "A field, however, that has a moderate descent," he remarks, "may be formed into a water-meadow if it be so situated that it can be watered; but better still is one where the surface is even, and the descent easy and gentle, so that either the rain or water from rivers which overflow it may not remain on it too long, and which allows the water to glide off quietly. Hence, if any part of a field is intended for a meadow, the water standing on it must be let off by drains, since there will be a loss either from too much water or too little grass."

Pliny, another author, says, in reference to this subject, that "meadows ought to be watered immediately after the spring equinox, and the water kept back when the grass shoots up into stalk."

Virgil, also, in his well-known Georgics, Book I, alludes to irrigation:

> "Of him who on his land,
> Fresh-sown, destroys each ridge of barren sand,
> Then instant o'er the levelled furrows brings
> Refreshful waters from the cooling springs;
> Behold, when burning suns or Syrius' beams

Strike fiercely on the fields and withering stems,
Down from the summit of the neighboring hills
O'er the smooth stones he calls the babbling rills,
Soon as he clears whate'er their passage stayed,
And marks their future current with his spade:
Before him scattering they prevent his pains,
Burst all abroad, and drench the thirsty plains."

The practice of irrigation likewise prevailed in various parts of the Roman empire; and even in the dark ages, we are informed, when agriculture, together with other arts and sciences, declined, irrigation was carried on as a remarkable exception in countries where despotism and feudalism existed.

The Moors seem to have introduced or prosecuted it with increased vigor in Spain when they held possession of that country. But particular notice of the modern condition and bearings of the subject is reserved for another place in these pages, it being merely observed now that massive, well-constructed aqueducts still found there attest the high value which was attached to irrigation as an important means of increasing the fertility of the soil and adding to the agricultural riches.

In a country like Germany, in which, for a century past, so much attention and research have been devoted to the various branches of practical as well as of scientific agriculture, we naturally look to find a rich literature on subjects connected with irrigation. This exists, partly in separate treatises, and partly, and in a greater degree, in numerous articles in agricultural journals and portions of extended works relating to the general subject of the culture of the soil and domestic husbandry. Fraas, one of the most recent writers, in his History of Agriculture, (Geschichte der Landwirthschaft, &c.,) remarks that in modern times certainly no question has more engaged the attention of the learned agricultural public than that of extensive meadow irrigation, wholly different from the primitive systems of the people of the southern regions, or, indeed, of the people who, in the gray antiquity, conducted the civilization of the world. He states that in all parts of Germany such extensive preparations exist. Aside from the practical agriculturist, its literature, even through special journals devoted to the object, has been widely diffused and found numerous readers. Still, it has not attained its true position, either with the government or in general practice; and all sorts of doubts have been raised, not in respect to its practicability, but the mode of carrying it out without injury to private interests, and the great principle of securing the highest profit. He first presents the urgent necessity of irrigation, as seen from a historical point, in which he makes some interesting statements as to the condition of that portion of Europe in consequence of its progressive civilization. Since the opening of what were the gloomy forests of Germany in the time of the old Romans there are not the same dense fogs as then, nor such pouring rains and storms. The consequence is that the climate is more dry; and this state of things keeps pace with the laying open of forest lands and drying up of marshes. The drier the climate and the land are, however, the more need there is of moisture to be supplied in the culture of grasses in the meadows; and this is urged as a strong ground for irrigation. In former times July was called the hay month, whereas now the hay is gathered in June. The conclusion is drawn from such facts that the time is coming when the governments must seek to introduce a system of agriculture related to irrigation from streams, and leading out water by regular constructions, levelling of surface, and all its various forms, not only for meadows, but likewise for cultivated fields, which may be thereby enriched and made to yield a better income.

In 1763 a prize essay was published on the subject by J. G. Schreber, in which he treated of the general principles and modes of conducting irrigation. The rules were laid down by Stapfer also, and again by Bernhard. These works have been followed by those of numerous other authors, in which the subject is discussed in its different bearings, embracing the results of observation and experience. Fraas, after a brief review of the points of greatest interest, comes to the conclusion that it is evident that theoretic meadow-culture is in advance of the practical, and that it is not less clear, also, that natural meadows are yielding more and more to artificial; that irrigation will soon dissipate the old relations; and that, in view of the facts as to the forests and general progress, a higher culture in this regard will come in, and the benefits of such a cultivation will be more fully realized.

No author on agriculture in Germany has probably exercised a wider influence than Thaer. In his Principles of Agriculture he has given a number of pages to the subject under notice. A zealous advocate of the humus theory, in which he has also many recent followers, his view of irrigation is based on the idea that all the nutriment of plants is furnished in a state of solution. He lays down the position that irrigation is "one of the most useful and important of all the operations within the province of the agriculturist." Moisture is essential to vegetation; and water, either directly or by decomposition, contributes materially to the nutrition of plants. However Thaer's theory may be affected by

Liebig's subsequent claims in behalf of another mode of accounting for the nurture and growth of plants, yet all subsequent writers seem to accord with his exhibition of the facts, and the process as well as the grounds in general on which he recommends the practice of watering meadows and fields. Indeed, it would seem that the practical agriculturists of Germany have not as yet given their adhesion to Liebig's views. Accordingly, in all the treatises and discussions on the advantages of irrigation, we find a decided leaning to the opinions of the earlier teacher. Schwerz, Veit, Kœppe, Hlubek, and Von Lengerke, among the best of these authors, adopt them. Thaer himself did not claim any great experimental knowledge of his own on the subject, as his adoption of the plan was limited to a small extent of surface—some few acres; but he had industriously gathered his information from various sources, and especially from countries or regions where it had been most successful. He also brought his large knowledge of agriculture in general to bear upon the question in settling the principles on which it should be discussed. He states clearly the advantages to be derived from a resort to irrigation; the difficulties which are to be removed; when and where it may be best practiced; and the modes adapted to the varieties of soil and surface, and other circumstances affecting it. His remarks are excellent, and the subject is placed in a clear, strong light, indicating that good sense and discernment which characterize his work as a whole, and which entitled him to the eminent place so universally assigned him as the pioneer of combined scientific and practical agriculture in Germany. But many years have elapsed since his work was written, and new experiments and observations have added to the mass of accumulating materials, so that it is unnecessary to refer to them in detail; since whatever may be useful in this respect may be embodied with the later considerations of authors hereafter to be quoted.

In Von Lengerke's Annals of Agriculture (Annalen der Landwirthschaft) there is an article entitled "Reply to the questions proposed by the Royal College of Rural Eeconomy respecting the formation of Water Meadows, by Chief Bailiff Sydow, of Steinbrusch," which, in a few pages, embodies the results of practical attention by a man of sound judgment, and the substance of which may be profitably introduced here to show the general aspect of the subject in that country. Sixteen questions were proposed, which, with the answers, cover the main points embraced in such an investigation.

The *first* question is as to the effect which water has, irrespective of accidental mixtures, to promote vegetation. The reply states that the effect is to cause and promote the process of putrefaction, by which nutrition is prepared for the vegetable kingdom. The cutting off of air and heat, however, by an excess of water, and especially by freezing, does not accomplish this purpose. "But," says Mr. Sydow, "water appears to impart, so to speak, a relish, combining with the nutriment of plants, and conveying it to them; and this is indicated by the fact that there is no plant in a living state without more or less hydrogen and humus from which water has been entirely evaporated is ineffective for vegetation. As regards the grasses especially, the principal part of them in their green state consists of hydrogen, and in a sandy soil, destitute of humus, by means of water a vegetation otherwise unattainable may be called forth." Whether this adaptation of water for the nutrition of plants is in the water itself, or derived from long contact with the air, he does not pretend to decide. Its effect, however, is unquestionably increased by such long exposure, where it may take in nutritious particles, as may be seen from the fact that water which comes directly from springs causes but a scanty vegetation. The conclusion is evident that, though without artificial additions of humus, water may call forth vegetation, yet that lake, river, and rain water have better success in this way than the water of wells, springs, and fountains.

The *second* question proposed referred to the influence which the temperature of water exerts in the matter. Here, it being assumed that some degree of heat is necessary to vegetation, the kind of water to be used for this purpose is at once shown. "Experience teaches this, since ice, or water without heat, hinders the requisite putrefaction and the growth of plants; so that, as a practical question, it relates to the degree of heat conducive to the end. Unquestionably the highest degree the water can obtain in the open air, by means of the sun, is the best. A warm rain is more successful for the growth of plants than a cold rain; and the irrigated meadows in the greatest warmth of the atmosphere, so far as they receive the necessary quantity of water properly distributed, have a more luxuriant growth than others."

As to the influence of accidental mixtures with water, which of these are the most beneficial or are injurious, Mr. Sydow speaks of the decidedly beneficial effects of slime, animal and vegetable elements, such as are borne along in their course by rivers; and even mixtures of clay and lime, if not as good as others, he does not regard as exactly injurious. But earths containing iron are hurtful, only a scanty growth of coarser grasses and plants being the result. Acids, too, such as are formed in boggy and marshy places, act injuriously.

In reference to the character of the soil with respect to the success of irrigation, as to the combination of natural elements, and to locality or situation, his experience is that there is

no difference in sandy or clayey soils with an equal proportion of humus. It has been found so in experiments on previously unfruitful sandy soils. As regards the ease of practically carrying out plans of irrigation there is quite a difference, a sandy being more porous, and allowing the water more readily and in greater quantity to soak into it than a clayey soil. To counteract this disadvantage, in some cases resort has been had to building walls above the conducting trenches so that the water may be dammed up high enough to reach a little above the margin of the trench, but not above the walls. It then percolates and moistens the ground on a lower level. In the places where the soil is not porous enough, and a richer supply is needed in the irrigation, openings are made in the sides of the walls of the trenches, and it thus becomes spread through the ground. By this process the object has been secured, considerable water saved, and, on the whole, a greater product obtained than by irrigation over the surface. This is especially important where, as is often the case, there is more land than water at any one's command, and a careful economy of the water may be requisite. If there be plenty of water for a sandy soil, irrigation on the surface is, however, preferable. But care must be taken in this latter case that the surface-irrigation be not used before a turf or sward is formed, as the soil would be washed off, irregular runs of water caused, and the object of distributing the water equably thus hindered. For a clayey soil this method of moistening will not answer; for, as it is not porous, the too great consumption of water from the soaking in does not exist. Peat soils, previously drained and covered with sand some inches, are also not ill-adapted to irrigation.

Mr. Sydow places a good deal of stress on the influence which the proportion of humus in a soil has in determining the benefits to be derived from irrigation. A soil poor in humus, without the aid of manure, promises little or no profit. In such an artificial meadow, he thinks, it should be thinly manured every three years, partly with ashes, and partly with muck and cow-dung, at the rate of three or four loads of the manure to the acre, and ploughed up also in the spring to bring the manure into contact with the soil. As to the nature of the surface, a perfect level is not fitted for irrigation; the water, not being able to flow off, forms marshy spots, which must be drained and not allowed to stagnate. A sloping surface is therefore required; but as the greater the inclination the greater the consumption of water, and as the production of grass is not in a like proportion, a moderate slope such as permits the water to flow off easily, and to leave no excess, is the most advantageous. In natural meadows, however, the surface must be taken as it is.

There are soils and circumstances which resist successful irrigation. Land suffering from bogs that cannot be drained, or only at great expense, or those soils the elements of which hinder vegetation, (for example, those which contain large quantities of certain mineral matters,) will always be unfruitful, even if irrigated. On any other soils adapted for manuring, and with sufficient rain for the growth of plants, an active vegetation may be called forth by this means.

An important question relates to the quantity of water needed as an average on any given extent of land. The answer is, that the supply depends on a variety of circumstances, such as the lay of the land, the subsoil, whether the water is used more than once or several times, &c. Some general principles only can be given, such as the greater the slope the more water; sandy more than clayey soils; coarse sand more than finer; coarse gravel with the same subsoil can hardly be saturated. Every soil, too, at the outset requires a greater quantity of water than afterwards, when properly impregnated with the slime. It cannot, therefore, always be determined beforehand how far the water at disposal will serve for the purpose of irrigation. We must proceed gradually and adapt the extent of watering to the supply, as it appears in the process. In an experience of twenty years on ground having fine sand for the upper stratum and clay and gravel in part for the subsoil, the water being used over and over in distinct portions with, in general, but a gentle slope, the use of water for sixty acres during the irrigation for twenty-four hours amounted to 200,000 cubic feet.

As to the length of time, the seasons of the year, and the time of the day most favorable and efficacious, Mr. Sydow says the first of April, only leaving off during the first mowing, and then, when the hay is taken off the meadows, continue till the aftermath is mown. During this period the water is to be let on three or four days in succession, and then held up the same period of time, to allow it to run off before resuming the irrigation. The water stands on one half of the meadow three or four days, then being let off on the second half an equal length of time. From the gathering of the aftermath the meadows lie dry, later watering having been found prejudicial.

To the inquiry, How much water is consumed by evaporation and soaking in, and what share do the state of the atmosphere, the seasons, the time of the day, and the quality of the soil bear in this consumption? the reply must be given that the definite portion so consumed cannot be stated. It is governed by various circumstances, and depends on the state of things at a given time. In a sandy soil, and the drier and warmer the weather, of course, the greater must be the consumption. Mr. Sydow reckons it in his meadows at nineteen-twentieths of the whole quantity conducted on the ground.

The distance of the water-level of the drains from the surface to be watered, and also the depth to be given to the various trenches and feeders, are the next points of investigation. Mr. Sydow states his main conductor to be, at the water-level, twelve feet, four feet wide at the bottom, and four feet deep, with a descent of two feet in a mile. This is found sufficient. In a loose, sandy soil the fall might be six feet, without carrying away the banks; with a greater descent the flow of water would be increased. But the general condition of the ground and local circumstances must determine this where much fall is at one's command. The large conductors of the water upon the surface irrigated are, at the water-level, five feet; at the bottom two feet broad, two feet deep, and half an inch fall every six feet. The small feeders need not be more than one foot broad or deep, and with no descent, their object being, not to conduct the water, but simply to distribute it equally. In the drains the water-level is nine to twelve inches deeper than the surface of the ground irrigated, and with a descent of one-fourth to one-eighth of an inch per twelve feet. Their breadth and depth depend on the quantity of water to be drained and the land to be cut through. As to the natural method of irrigation, the slope of the water does not come under a separate consideration, as in such cases it is used as it is without alteration. No more is needed than for the water to flow off gradually. Two inches to 120 feet, if watered only alternately, is sufficient. Any certain or definite direction is not requisite for the whole surface to be irrigated in this descent; if it is formed partially by elevations and depressions, such as almost everywhere we find the lay of ground, it will answer. If needed, draining by trenches must be added. A larger descent than the above mentioned is advantageous to the hay crop, though it requires more water; and in case of deficiency of water, or in a sandy soil, which absorbs a large quantity, it is not advisable on the score of profit. Irrigation can, however, be conducted on the steepest declivities, if care be taken to prevent the water from constantly running off and the soil is covered with a sward, and the walls of the trenches are secured from being broken through.

The fall in the artificial water-meadow must depend on the particular circumstances of each case. There are natural circumstances, in given cases, which all may avail themselves of without ploughing up the surface, while in other cases resort must be had to such means. The aid of the natural condition of the soil must be made use of, and irrigation can be effected by here and there draining and cutting off, so as to regulate the slight inequalities of the surface of the ground, for the purpose of constructing the conductors and feeders, and in such cases proper artificial cultivation may be wholly dispensed with.

In estimating the cost of preparing natural irrigated meadows, compared to that of meadows artificially irrigated, it is difficult to arrive at any very satisfactory results. They are so different, and so depend on local circumstances, that an estimate in general is impossible. The greater part of the expenses are those which arise from conducting the water upon the surface to be irrigated, and these vary almost indefinitely. Leaving that out of the account, the cost of the constructions, or the expenses of laying the conductors, feeders, and drains, in natural meadows, are stated as from two to five thalers per morgen, (about $3 20 to $8 for a little over an acre.) A similar meadow, laid out in beds, costs considerably more—Mr. Sydow thinks tenfold. The product of his meadows, irrigated as he describes, he gives at an average of three tons to the acre. The hay is regarded as of equal value with that of meadows overflowed and manured by the slime left upon them, and the fodder, for cattle, horses, and sheep, as healthy and nutritious.

These views of Mr. Sydow, which were published in 1842, correspond to those of later writers, and are, no doubt, the same as are entertained at the present day in Germany in respect to the fundamental principles of irrigation. Quotations might be largely made and extracts multiplied, but it is unnecessary, as this mode of improvement of lands has not been conducted on any very broad scale in that country.

In France and Belgium attention has been given to the subject. It is evident that it has been regarded as a matter of public interest and prosecuted with more or less success. From time to time persons have been commissioned in France to visit regions where irrigation has been most successfully applied, and to examine and report upon the existing state of this measure, and how far it may admit of application at home, that equal or greater results may be secured, as well as upon the legislation necessary for carrying out the different modes of irrigation upon the uncultivated tracts allowing of such better means and even increased improvements. Action has doubtless been had on the information furnished and the end still kept in view, as is evident from allusions to it in the different agricultural journals of France.

Richard, in his Dictionnaire Raisonnée d'Agriculture, under the head of Irrigations, gives the natural meadows of France at 4,200,000 hectares, (at about 2½ acres per hectare,) of which not more than 95,000 hectares are irrigated. The remaining 4,105,000 hectares, which now receive only the water of the sky, or rain, he asserts, could be tripled in their productive value by means of irrigation. As the necessity of greater supplies of food becomes more apparent, no doubt the attention of the government will be directed still

more to this means of securing such an increase, and irrigation will probably be conducted on a corresponding scale. This judicious care of supplying water as needed, connected as it is with suitable drainage, would be useful not only for times of drought, but likewise might prevent some of the disastrous consequences of the wet season, of which complaints have been made this year as so threatening to the prospects of the harvest in that empire.

The Count de Gourcy (in his Agricultural Tour in France, Germany, Hungary, Bohemia, and Belgium—a work of which a notice is given in the Quarterly Journal of Agriculture—) speaks of an irrigated tract on the banks of the Moselle which consists of upwards of 1,200 acres; and some idea, it is said, may be had of the labor and cost required to complete it when it is stated that the course of the river was turned several times. The result has been that the most arid and sandy tracts were soon covered with turf, and very indifferent and unproductive land converted into beautiful meadows. A few leguminous seeds were sown among the grass, and especially white clover; also, English and Italian ryegrass. The third year, from 3,000 to 4,000 kilogrammes (about $3\frac{1}{5}$ to $4\frac{1}{5}$ tons) of dry hay were obtained from every $2\frac{1}{2}$ acres. On the oldest of these meadows three oxen of large size were fattened on two and a half acres, and it was expected that four would be. Other similar meadows are mentioned which are cut three or four times in a year.

The methods of irrigation in France are in general so similar to those practiced in other countries that they need not be dwelt upon particularly here. One kind, however—a species of catch-work irrigation for uneven surfaces—called *Irrigation par Razes*, is somewhat peculiar, and may, therefore, be presented as described in the "Journal d'Agriculture Pratique" for 1859.

This system, which is also called "sloping trenches," (rigoles en pente,) is well adapted to lands that are irregular. Mr. Pareto applied it to lands which had not more than from 3-1000 to 8-1000 of a meter fall to the meter; (a meter is equal to 39.37 English inches;) but it is said to be more successful in case the fall is from 2-100 to 8-100. In the Luxembourg and in Auvergne it is employed with much steeper falls; but the irrigations are quite irregular. In general, irrigation *en epi* ought only to be used to complete irrigation by level trenches. It is practiced on the top, or ridge of heights, on the side of the fall, by means of distribution trenches, proceeding from the supply canal, in which, on each side, originate inclined trenches, diverging like the beards of an ear of grain, and which are called *razes*, their size lessening up to the extremity where they terminate in a point. These trenches, in proportion as they are contracted, fail to contain all the water which runs there, and it is accordingly turned off quite regularly along their whole length. In the valley passages supply trenches are hollowed out and made to conduct the water either into a trench on a level, which then performs the office of a feeder to the land below, or into the principal drain for carrying off the water. Thus, besides the conductor which brings on the water, and which is constructed precisely as for irrigation by level trenches, we must make the large feeders, the smaller or diverging feeders, (*razes*,) the small drains, and the main drain.

The main feeders are drawn along the line of the greatest slope. Each of them is connected with the conductor by a wooden nozzle furnished with a gate, and has a uniform breadth up to the first pair of small side feeders, then suddenly diminishes in breadth as it leaves that point to continue the new section up to the second pair of side feeders, and so on. The constant depth is $\frac{1}{5}$ to $\frac{1}{4}$ of a meter on the whole length. The breadth depends on the quantity of water to be distributed. In an ordinary surface, with a fall of 7-1000 of a meter per meter, a length of 90 meters, and three pairs of side feeders is best. Mr. Pareto gave to the first main feeder a breadth of 45-100 of a meter; to the second, 30-100; to the third, 15-100; and the irrigation, in which he could dispose of much water, succeeded well. It is admitted that, as the small side feeders, to distribute the water regularly and properly, ought not to be more than 25 meters long, the distance between two successive side feeders should not be over 50 meters. Some irrigators have 80 meters; but this must depend much on the nature of the tract of land and its conformity of surface. We ought carefully to consider any plan of irrigation before adopting it on the land, that we may be certain of deriving from the system every possible advantage. This is ordinarily neglected, and frequently the feeder is traced out on the apparent state of the soil, and the feeders are afterward executed by making the water follow in them in order to avoid the use of the level.

The feeders, which start by pairs from each side of the main feeder, have the same depth at their source as the main feeder, whether one-fifth or one-quarter of a meter, and a breadth of one-quarter of a meter. The depth then diminishes progressively, and at the extremity is not more than fifteen one-hundredths of a meter, and then terminates in a point. They are made, not by following the lines of level, but with a small regular fall of one in one thousand meters in the less impervious soils, and of five to one thousand in those more so. Generally, two of the small side feeders start from the same point of the main feeder, but

this is not the absolute rule. The length of these small side feeders is limited to about twenty-five meters. The distance between any two pairs depends on the nature of the soil and on the fall, and is commonly from three to fifteen meters, the minimum corresponding to a system of irrigation by level trenches, stronger descent, and the greatest porousness of ground. The side feeders are placed along a main feeder, not in the way of prolonging it, but opposite the middle of a section of it, and it thus separates two pairs of successive side feeders. On the same main feeder there are seldom placed more than two pairs of the small side feeders. The trenches, acting as small drains, are placed at the bottom of the valleys between two main feeders, and either meet the principal drain, or, when the ground presents a large extent, a level trench which performs its office of conductor for a strip of the lower ground. The distance between the level trenches charged with the office of conductor ought to be embraced within 60 to 100 meters. It is well to have them directly connected with the conductor, the better to scatter the water across the whole extent of the irrigation.

If there be but a slight fall, in order that we may have a proper state, we arrange accordingly, the small drains on the side, as we do the small side feeders, and place them in the intervals between two successive systems of side feeders. These small drains have a size proportioned to the quantity of water they are to receive.

The manner of forming the trenches in the system of side feeders is the same as that employed in the level system of irrigation. The price of the conductors, feeders and drains is, on an average, one centime (less than one-fifth of a cent) for the meter; the price of the small feeders is estimated at two-thirds of that of the small drains (or sixty-seven one-hundredths of a centime) per meter; and the large trenches, on the level, cost in proportion to their size.

To furnish the water, the sluice doors which connect the conductors with the main feeders are opened, and from them the water runs into the small side feeders, and when these are filled it flows upon the ground, and then is received by the small drains. However well the system may be established, the flowing upon the land is never effected with perfect regularity, and the irrigator must be at hand to place turf or little boards either in the feeders, toward the course of the system of side feeders, to cause the water to flow back there, or in the side feeders themselves, to force the water to flow off uniformly. It is estimated that this system of irrigation requires double the cost of supervision called for by level irrigation. The draining is effected without difficulty when the sluice doors of the feeders are shut.

Count Gasparin, in his *Cours d'Agriculture*, gives a rule to this effect, for estimating the quantity of water: As one-seventh of that which falls in rains runs off by rivers or streams, by multiplying one-seventh of the water fallen by the surface of the soil which slopes toward the valley, we have approximately the cube of the water which flows into the place where it is received.

The evaporation of the water is a most variable element, according to the more or less hot or windy climate. Cottle found that the evaporation at Montmorency was five hundred and ninety millimeters, and at Orange, in a windy, hot climate, one thousand eight hundred and seventy-five millimeters. The Canal du Midi loses on an average, from this cause, three to four centimeters per day. M. Comoy estimates the loss of the Canal du Centre at thirty-five millimeters per day in clayey soils, and at twenty-five millimeters in the sandy ground, during the summer. Making these deductions, we shall have the number of hectares which can be watered by dividing the number of cubic meters which remain in the basin or place of reception by one thousand, multiplied by the number of irrigations needed on a tract of land.

Bored or artesian wells are also recommended where the strata of the ground give reason to expect water at a certain depth. Some of these are carried to great depths, but the previous calculations are often of great accuracy. It was conjectured from the strata at Grenelle that water would be found at the depth of five hundred and fifty to five hundred and sixty meters, and it was found at five hundred and forty-eight.

The department of the Eastern Pyrenees appeared to be one of those where the greatest volumes of water might be obtained. Mr. Durand bored a well at Bages which produced two thousand cubic meters of water per day; at Tours, at fifty to one hundred, they obtained four thousand cubic meters per day; at Grenelle, two thousand four hundred litres on the surface of the ground per minute, and one thousand one hundred and forty litres for thirty-three meters depth. But such success is not to be noted everywhere, bored wells producing from fifty to one hundred cubic meters per day being much more numerous.

In regard to the price of irrigation, Count Gasparin remarks that on the coast of Craponne it is from five to six francs per hectare (two and a half acres) at Salon; and twenty-two francs at Arles, not the greatest distance. On the Canal Crillon it is twenty-four francs. This last canal cost six hundred thousand francs, and is about to be sold for three hundred thousand francs, though it uses all its water. The income of the Canal des Alpines is fixed by law at one and a half litre of corn per acre, or fifteen decalitres per hectare. This is a

good precaution, but at the average price of corn, twenty-two francs, the price of irrigation of a hectare will not be less than thirty-three francs.

In comparing the prices of water raised by machines moved by different kinds of power, Count Gasparin says the water on the Canal Crillon costs, per cubic meter, 0.005 of a franc; that of Martesana, 0.0012; while that raised by human strength, the cubic meter costs 0.0149; by horses, 0.0027 to 0.0032; by wind, 0.002 to 0.005, according to its situation; by steam-engines of five horse power, 0.00119; and of forty-five horse power, 0.00098 of a franc; but it is seldom that it is not necessary to raise it to the height of several meters for irrigation; and, at the height of four meters merely, ten thousand meters will cost—

Human power	596 francs.
Horse "	128 "
Wind "	80 to 100 "
Steam-engine, 5 horse power	48 "
" 45 "	39 "

The advantages of irrigation are presented by many of the French writers on agriculture. Count de Gourcy speaks of the magnificent irrigated meadows in the environs of Firbone, where he states that land valued at eight hundred francs was raised to two thousand four hundred francs. The first cut of hay, in the third year, sold at from forty-eight to fifty; the second at thirty-two to thirty-four francs per *juchart*—44 ares (one and one-tenth acre). In the winter each meadow receives water twelve hours for twelve days; in summer six hours for twenty-four days. It is irrigated up to the evening before mowing, but great care must be taken to let on only a slight veil of water, just enough to cover the ground; a thicker one injures the crop. The level ground is divided into plots of forty-four ares each, in an oblong form, and each portion has its sluice to retain the water whilst it is at disposal for irrigation.

Several methods of noting the mean quantity of water necessary for irrigation are described in a valuable work entitled "Colonisation et Agriculture de l'Algérie," by L. Moll, viz: 1. By the total volume of water employed on a given surface, as upon a hectare, during the season of irrigation. 2. By the continued loss of water. 3. By the number of waterings, the volume being determined beforehand.

The season of irrigations is at the maximum six months; that is to say, from the first of May to the end of October, in the south of France and in Italy.

The greater number of agricultural writers who in modern times have treated of irrigation have adopted the first method of valuation; and after many statements made in different countries, especially in the South, have adopted as the average number 10,000 cubic meters per hectare for the whole season.

Without entering into any discussion here as to this number, it may be remarked that this method of valuation is inconvenient and but little practiced, except in a single case, when irrigation is carried on by means of artificial reservoirs, or of machines which do not work constantly, or merely yield a feeble volume of water and raise it at first into a basin, whence it is directed upon the soil.

For all other cases the second method is preferable,—the valuation by the continued drain of a volume of water regularly noted during the six months of irrigation. This method, indeed, is allied to the operations in gauging, and to calculations which the formation of the canal of supply renders necessary. It is known that at low-water mark the course of the water from which the canal is derived notes a volume given in a second. It is inferred that by taking a quarter, a half, or the whole of this volume of water, we can irrigate a definite number of acres; or else that number is fixed beforehand, and the gauging indicates that the run of the water is amply sufficient; and that nothing more is needed than to calculate the section and fall of the canal in such a way that there may be delivered in a second as many times a certain volume of water as there are hectares to irrigate.

It is probable that the desire of presenting in a second, as an average, simple and perfect numerical data which will fasten themselves readily in the memory, even more so than the observation and calculation, has caused the adoption of the number of 1 litre (61.02 cubic inches) of continuous water per second for every hectare (2½ acres.)

This delivery represents: For the hour, 3,000 litres, (660 gallons,) or 3 cubic meters, 600 litres; for the day, 86 cubic meters, 400 litres; for the month, 2,592 cubic meters; for six months, 15,552 cubic meters. Thus, to irrigate 1,000 hectares there is needed a canal of supply having a capacity of 1 cubic meter per second, and so on.

Further observations have shown that this number of 1 litre per hectare is too high as a mean, or average. In the department of the Eastern Pyrenees, portions of which being plain have perhaps the warmest and driest climate of all continental France, there are areas which receive a sufficient irrigation by a continued delivery of a little more than a fourth of a litre per hectare. It is true that in that country, as has already been remarked, the

mode of irrigation—that is to say, the disposition of the ground—is of a kind to reduce the drains to almost nothing; that consequently canals in general are made with much care and in a manner to avoid all losses.

In considering that number as exceptional, we may, at least, admit with M. Nadault de Buffon, as a very convenient mean, the number of two-thirds of a litre of continuous water a second for a hectare. Every litre of continuous water per second will, therefore, irrigate a hectare and a half, and a cubic meter will be enough for 1,500 hectares.

Now, supposing there are six months of irrigation, this number of two-thirds of a litre of continuous water per second gives for the total volume a little less than 10,400 cubic meters for the season. This number, as may be seen, agrees in a remarkable manner with that of 10,000 cubic meters before mentioned.

But of all the methods of estimate, that most practiced unquestionably is by *irrigations*. It is known that the introduction of water upon a tract of ground is not continuous except on some spots at certain periods. The quantity of water by irrigation per hectare varies, no doubt, according to the soil and the system of irrigation, but much less than the irrigations, which run from four to sixty, and more. In a soil of moderate capacity, as that of the greater part of Algiers, and with the systems of irrigation by infiltration, (subterraneous,) by renewal of the water, or by beds, and even by ridges, when they are slightly inclined, 300 to 500 cubic meters—on a mean 400—per hectare are enough for each irrigation. Such a volume of water spread uniformly over one hectare will give 4,000 litres per are, and 40 litres per square meter of the surface; and, supposing it to be extended regularly over every portion of the surface of the soil, it will form a veil of water four centimeters deep. Now, we know that a rain of two centimeters high is a very strong rain, and penetrates deeply into the ground. So it would not be necessary to use this large quantity of water if we had the means of diffusing it with as much regularity as is done by the rain, and if, subsequently, the evaporation was not much greater after an irrigation in a dry season than after a rain, which charges the atmosphere with moisture. We may start, then, from that basis to estimate the quantity of water required in different agricultural conditions:

1. *Gardens.*—This mode of using the soil requires the most water. In the South of France, in Italy, and in Spain, six to twelve irrigations are bestowed on gardens per month. Six being more frequent than twelve, we may take eight as a mean; that is, two irrigations per week. Now, allowing 400 cubic meters for an irrigation, this would be 800 for a week, or 20,800 for the six months of the irrigation period, just double the volume in a delivery of two-thirds of a litre a second. Consequently a supply-channel designed for the irrigation of gardens ought to deliver per second as many times $1\frac{1}{3}$ litres as there are hectares to irrigate. This agrees perfectly with the facts collected in many gardens amply irrigated in the environs of Perpignan, as well as those furnished by M. Maffre, in his work on the kitchen gardens of the South. According to that able observer, the *Norias* constantly used in the gardens in the neighborhood of Pezenas, and which, worked by one mule, draw water from seven to eight meters deep, may furnish in $6\frac{1}{2}$ hours of labor a little more than 108 cubic meters of water. It is reckoned that three days are needed to irrigate properly one hectare, which thus requires a total of 525 cubic meters an irrigation, each portion being successively watered every three days at the rate of $3\frac{1}{4}$ cubic meters per acre.

2. *Natural and artificial meadows.*—Except in special circumstances, these are not watered oftener than once per week; most commonly not more than twice or three times a month. Allowing the same volume of water for a watering, and one irrigation a week, we have for each hectare just the quantity furnished by two-thirds of a litre per second; that is, 10,400 cubic meters for six months of irrigation.

3. *Plantations, and annual cultivated plants, (cereals, maize, flax, &c.)*—We calculate in general on half the quantity needed for meadows; that is, one irrigation every 14 days, requiring 5,200 cubic meters for the whole season, equal to the continued delivery of one-third of a litre per second for each hectare.

The foregoing relates to Europe. It has not yet been proved that these estimates will apply to Algiers; but as they apply to countries like Spain and the South of France, where the summers are really only a little less hot than in Algiers, but more dry, so they are assumed in treating of that climate. In fact, the *mistral*, that great drier up of the Mediterranean departments, blows also at Algiers during the greater part of the summer; but it is after it has passed over the sea and become charged with vapor. On all that coast of Barbary the nights also are fresh and moist, and the dews very copious. All this leads us to believe that for gardens 800 cubic meters in two irrigations, and for natural or artificial meadows 400 cubic meters a watering, would be amply sufficient for a hectare in a week Taking also into consideration the use of the soil for various crops, two-thirds of a litre of continuous water per second, or twenty-six irrigations of 400 cubic meters each, or a total of 10,400 cubic meters for the season, may be adopted as a very proper mean in Algiers for the hectare.

All that has been said relates to a soil of mean compactness. If the ground is sandy,

these data will not apply. A very sandy soil, situated near Paris, and sown with lucerne, required for each irrigation 15 cubic meters of water per are, or 1,500 meters per hectare; and, moist as is the climate of Paris for three or four months, two irrigations were required a week, which were reduced to but a single one during a month and a half to two months, making for the season 34 to 40 irrigations, which, at 1,500 cubic meters, form an enormous volume of 50,000 to 60,000 cubic meters per hectare, or five to six meters for the square meter of surface, or a veil of water five to six meters high over the whole surface irrigated. It is true that there are five to six cuttings of the lucerne, and that this was one of the most sandy and porous of soils that can be found; and, situated at the very entrance of Paris, it could not be tilled.

Gauging the course of water or spring to be used is always a judicious course before putting ground under irrigation. When the course of the water is of importance, the administration requires gauging before a grant is given. But in any case the good husbandman ought to know approximately the state of matters and what he wants. In the case of irrigation, as in navigation, it is the low-water mark which must be determined, not only as to volume, but as to its period. In the use of a spring or feeble run of water, on which there is fall enough without danger of losing the water in filtrations, the best and most exact method for ascertaining the delivery is to cause the whole of the water to run into a receptacle of known capacity placed under the fall. With a counter, or a second-hand watch, or even an ordinary watch, or by beats of the pulse of a person in good health, (generally a little more than 60 per minute,) observe the time necessary to fill the measure, and, dividing the contents by the number of seconds, the quotient obtained will be the number of litres delivered by the run of water in a second.

When pressed for time, or when the run of the water is too great, or when there is no fall, the method of *water gauges* is used. For this purpose the bed of the water is made as uniform as possible for a certain length, either confining it by shutting it up in its natural banks, or by constructing an artificial canal by means of boards. At some meters above the place where the regular bed begins, place in the middle of the current a water gauge composed of a piece of wood barely heavy enough to sink below the level of the water, that the agitation of the air may not modify the traverse of the gauge. With a second-hand watch, or by the other means indicated above, the irrigator follows the gauge, setting out from the point where the regular bed begins to the point where it ends. This distance having been previously measured, and what the gauge has to run through being known, the superficial velocity of the water should be multiplied by 0.80 to get the mean velocity. For greater exactness repeat the experiment three or four times and take the mean of the results. The velocity being known, the section should be measured, for it is known that the capacity of the water is the product of the section and the velocity. If the bed can be changed into a canal, so that the bottom may be even and the banks parallel and regularly arranged, with or without slopes, the exact bearing of the section will thus be given very easily. This should be made on the top, at the middle, and at the bottom of the portion regulated by the course of water, and the mean thus taken. This method is subject to some inaccuracies; but still it is the only method commended to agriculturists when they cannot employ the first. But in treating of a thing as variable as the capacity of a brook or river, exact precision is not indispensable. The best gauging will not be exact half an hour after its application. The low-water mark, as already stated, is but vague; and, besides, where the low-water mark is that which notes the drying up, it may be more useful to know approximately the quantity of water which can be disposed of at different periods of irrigation, before and after the low water. What is most important to determine is the ordinary period of the latter.

Modules are also used for determining the volume of water. The module is an orifice of variable form and dimensions, cut into a vertical slab on which the water of the canal comes. An inch of water, or a cistern maker's inch, is adopted as the unit of comparison. The product of such an inch is:

In 24 hours	19	cubic	meters	195	litres	3—10
1 hour	0	"	"	799	"	8—10
1 minute	0	"	"	13	"	1—3
1 second	0	"	"	0	"	22—100

For the delivery, such as here indicated, the level must be established at a constant height of a line above the top of the orifices. In fact, the volume of water which runs off in a given time by an orifice, does not depend solely on its dimensions, but also on the charge, which is the result of the level of the water above the summit of the orifice in the feeding canal; also of the level of the water in the receiver. In the modules the orifices always discharge in the open air.

The pressure of the water must be considered as well as the velocity and the direction of the current, which alike influence the delivery at the orifice. As note cannot be taken of all

the disturbing causes in a canal, the orifice which includes the module is fixed on a kind of chamber communicating with the canal by a door which allows the introduction of water in such manner that it preserves a constant level above the top of the orifice. Such are the most approved modules in use where irrigation is conducted most scientifically.

In the 18th volume of the 2d series of the *Annales des Ponts et Chaussées*, Memoires, &c., (for 1849,) there is an able article on the Irrigations of the Moselle, in the Department of the Vosges, by M. Foltz, *Ingenieur des Ponts et Chaussées*, which contains some important as well as interesting details. He mentions the transformation of 800 hectares (2,000 acres) of barrens into fertile meadows by irrigation. One fact to which he calls the attention is that irrigation offers a sure and economical mode of fixing the bed of a river which has hitherto had a movable bottom. A new smaller, constant bed is formed which will no longer be exhausted. He refers to the valuable work of M. Nadault de Buffon as to the *first* system of irrigation mentioned, which is that practiced in the great irrigations of the South of France and North of Italy. Its sole object in the use of the water is to keep up the moisture of the soil during the dryness of the summer. The purity of the water, the abundance and nature of the matters suspended in it, are of secondary importance. But the soil must be good, the vegetable earth thick enough, and if this is not the case, recourse must be had to manure. This kind of irrigation tends to impoverish the soil, and this is the case the more water there is and the purer its quality. The *second* system is practiced in the calcareous soil of the Vosges and usually in other parts of France, especially in the North. It is suited to valleys in which the stream has a slight fall, the moderate supply is pure, acid, or charged with substances which are not adapted to meadows. In this case, either naturally or by artificial means, varied according to the character of the place, the waters are let on the meadows in the winter during a thaw, at every period when they are charged with the vegetable earth carried away from other points. It then deposits a light slime, very favorable to vegetation, and which will compensate for the waste of the soil. In the summer the irrigations are suspended, or all that is done to keep up the moisture of the meadows is by maintaining the water at a level as high as possible in the canals and on the stream. If the form and slope of the ground permit, during the dry periods, recourse is had to the first system of irrigation.

The second system, it will be seen, is like the one practiced on so vast a scale in Egypt, with this difference, however, that while the calcareous streams here irrigate ordinarily only meadows, in Egypt the Nile fertilizes also the land under tillage.

In the *third* system the water itself not only preserves the freshness of the soil; it acts also in continually bringing on it and at all times an extremely fertile slime. In summer to appearance it is perfectly pure, but on examination there is seen a little deposit which forms in the outset on the pebbles fine crusts of a deep bistre color that do not immediately break under the fingers. In this method the nature of the soil is of little consequence. Irrigations are found to succeed more easily on the pebbly surface deprived of vegetable earth than on spots where there has already been a beginning of vegetation. What above all is important is the nature of the water, and especially of the slime which it holds suspended. Up to a certain limit, the more water there is the more slime, and the better are the meadows. During summer only it is proper to reduce or suspend the irrigations according to the state of the vegetation of the meadows, and for the benefit of the harvest. This system is not adapted to the calcareous waters of the basin of the Seine, and still less so to the ferruginous calcareous one of Landes. But it is particularly suited to the valleys where the waters come from granitic mountains covered with forests, and of which the fall is great enough to allow the construction of canals of supply very near by. It exists on two slopes of the chain of the Vosges and the Black Forest, and in certain parts of Switzerland. The waters which come from the mountains of Auvergne, the Alps, and the Pyrennees, are fitted for beautiful applications of this system.

What distinguishes these irrigations is, that they unite at first the advantages of the two former modes; they allow watering of the meadows during dry periods, and they produce at all seasons a powerful irrigation which is at one's command. They may be applied especially on poor soils, because these irrigations in a short time produce a complete revolution, particularly when the soils are very porous. The works constructed along the Moselle are a beautiful exemplification of this system. M. Foltz describes them as follows:

The course of the Moselle in the department of the Vosges may be divided into two parts, very distinct from each other, from the summit of the chain of the Vosges to Epinal, and from that city to the boundary of the department. In the former position the river is shut in by wet watered meadows, and its system is very regular. In the latter, on the contrary, the bed of the river is very large. It is formed of a vast plain of gravel torn apart by a great number of the arms of the stream. These banks of gravel are continually changing their form. The soil is composed of pure pebbles, the size of which rarely exceeds 0.12-100 meter to 0.15-100 meter; (a meter is over 39 inches.) Sometimes it is covered with signs of vegetation, where the flocks of the surrounding communes find a miserable pastu-

rage. In 1823 the idea was conceived, by the brothers Dutrac, of transforming these tracts into meadows by means of supplies of water led out from the river.

They began to trace out the plan ; but they met with obstacles from proprietors, and it was not till 1827 they bought the small tract of Gosse, of 20 hectares, (50 acres,) situated directly looking down to Epinal. This experiment succeeded, and the work was then begun on a larger scale. The surface was divided into basins, ordinarily on the same river, and capable of being filled with the same supply of water. At the head of these basins were erected dams large enough to draw off the waters into a canal of 10 meters in length—the section of the mean of water in the basins varying from 5 to 12 meters, according to the extent of the tract to be irrigated. The canals are kept in a straight line, and at a level as long as possible. The water has only such surface slope as is necessary to cause it to run off, and varies with the number of the little drafts upon it. When the soil in general sinks considerably, the bottom is shut up by a dam of earth, and also when several sluices at the bottom transmit the water either at the continuation of the large canal or the distribution canal of secondary importance. The small drafts of water of indefinite number derive the water either directly from the great canal or from the secondary canals, and then water the whole surface of the ground. The drafts of water take place on the surface or from sluices at the bottom, according to the relative heights of these canals. The waters, after having run through the whole soil, are brought into the river by a system of drains for discharging the excess.

When the ground is level and the fields already prepared, the *bed* irrigation is adopted; but care must be taken not to give too great length, because if the feeders do not have a sufficient fall, the slime will not be deposited.

Gauging, &c.—The meadow of Gosse was irrigated by a canal, the mean section of which was 4.54-100 square meters, with a mean velocity of 0.50-100 meter, which gives a delivery of 2.27-100 cubic meters per second. This quantity of water irrigates without interruption 19 hectares, or there is used for a hectare 120 litres per second.

The draft of water of the Trois Communes, situated below, and which irrigates 40 hectares of the new formation, had for its mean section 6.50-100 square meters ; its mean velocity 0.59-100 square meter ; the delivery was 3.84-100 cubic meters, and thus 96 litres per hectare. The irrigation here was uninterrupted. At the end of the great canal was a sluice at the bottom, irrigating 20 hectares, with 1.86-100 square meter, and a delivery of 79 litres per hectare per second.

The meadow of Thaon has 200 hectares, but only 100 hectares are irrigated. The canal has a section of 12.24-100 square meters ; a mean velocity, 1.06-100 meter ; its delivery, 12.97-100 cubic meters. Every hectare irrigated receives 130 litres per second, or 65 litres per second for the whole meadow.

The meadow of Broquin receives a supply of 70 litres per second and per hectare.

In the third volume of the third series of the *Annales des Ponts et Chaussées*, Memoires, (1852,) there is a full and able article on the Hydrology of the basin of the Seine, by M. Belgrand, *Ingenieur*, &c., which treats of some questions of particular interest in reference to the subject of French irrigation, and embodies principles of general application, a few extracts from which may be usefully condensed and given here.

Before entering upon the subject, he remarks: "It is well to remember, 1. That in *granitic* regions the valleys are straight, irregular, and have a strong fall. 2. In *lias* they are larger, with a gentle fall and deep bottom. 3. In *green grit* (grès) the valleys are large ; the mean course of the waters increase very greatly ; their bottoms are flat, with little streams of water, and have a concave depth. 4. In *oolitic* lands and *chalk* the valleys are flat at the bottom, or even convex, and in the last case the course of water runs at the top of the convex surface. They are straight in the *lower oolite* and *hard lime*, in the *middle* and *upper oolite*, very broad, and very fertile in *chalk*, in case the upper part of the river traverses impervious soils and have turbid fountains ; also muddy when the greater portion of the declivities is permeable, and the fountains *(crues)* are limpid."

From these characters of the bottoms of the valleys it follows—

1. That the meadows of permeable lands, *(oolitic* and *chalky* soil,) which are wholly confined to the margin of the streams, are naturally irrigated in the winter by periodic fountains ; and when these fountains are limpid, the meadows are generally low, humid and even muddy.

2. That the zone of the meadows irrigated by fountains is much restricted in impervious soil. The meadows of argillaceous subsoil are the only ones which answer for fattening cattle. Meadows with a *porous subsoil*, which border on a river, are not suitable for that business. The granitic meadows that on the Higher Seine do not yield any plant substantial for fattening cattle, are good for young cattle and draught animals, which maintain a constantly fresh hair, (skin?) and every appearance of good health. These peculiarities of meadows, according to the nature of the subsoil, completely change the conditions of irrigation.

The marshes for pasture ought to be irrigated by a system of trenches, which are more simple and easier to repair than others. The periods of irrigations are not the same; the manures which the young cattle drop render the shooting of the herbage more precocious, &c., and in a word the management of the whole is different from that of other meadows.

This remark is of great importance. Indeed, where the culture of the meadows tends to develop itself on a larger scale, especially where the *hand*-work is scarce, we should manage for the second cutting by having recourse to pasture to avoid the *hand*-work which is needed for gathering in the crop. Too complicated a system of trenches, which excludes young cattle from the meadows, must not be adopted.

In studying the irrigation of a country, we must take into the account not only the nature of the subsoil, but also the *mode of consuming* the hay. The following questions are to be considered:

1. The season in which irrigations are to be made. These vary with the nature and destination of the meadows.

Meadows with an impervious and clayey subsoil.—In clayey soils the meadows are on the sides at the bottom of concave valleys, and in a great measure on a level with the river or fountain. From this situation it follows that we can irrigate during the whole season, even at periods when the rivers are overflown. Thus, as to winter irrigation in Nivernais, they begin after the heavy frosts in February and suspend during March, as the plants then begin to shoot, and the morning frosts would be of great injury to the drowned meadows. Great importance is attached by those in charge of it in Nivernais to February irrigation; they favor an early vegetation, which would be completely stopped by the frosts of March if the ground was not then deeply moistened.

Spring irrigations.—These recommence in April. It is then necessary to prevent the soil from cracking open (*crevasses*) under the action of the first heat of spring, and when the herbage is not a sufficient protection.

Irrigations cease to be useful from the 1st to the 15th of May, when the ground is protected by the herbage on account of its imperviousness, in a state of sufficient freshness. Abundant irrigations from the 15th of May to the 15th of June develop an excessive vegetation, whiten the herbage, and lessen the goodness of the crop.

If the meadows are to be pastured, irrigation must be suspended some days before putting in the cattle. The first cattle are let loose at the beginning of April, in the most forward meadows, which have scarcely any need of water. Toward the 15th all the cattle are fattening, and irrigation is suspended.

Summer irrigations.—In those rare cases when there is water in summer, the irrigations commence after taking off the crop from the 10th to the 15th of July. They are very useful when the ground is uncovered—that is, till the end of July—and less so when it is covered by herbage. But they cannot be injured as in spring, because the vegetation is no longer vigorous. The irrigations of autumn are good, though less fertilizing than in July.

Autumn irrigations.—From the heavy rains in November the cattle do much more injury to the meadow by treading it down, when they do not find grass enough; besides, the food is unwholesome and insufficient. They are, therefore, withdrawn, and irrigations not begun again till the heavy frosts set in.

The autumn irrigations, which are made with *turbid* waters, are very useful, because by their slimy nature as overflows, (*colmatage,*) they fertilize the meadows. Thus, in the impervious soils of the Higher Seine, these irrigations are useful in the whole season and last six months, viz: in winter, one month; in spring, one month and a half; in summer two and a half months; and in autumn, one month.

When the irrigations are made by means of the waters of a canal or river, in the calculations of the necessary water, we need only consider the summer and spring irrigations, because those of autumn and winter are made with an excess of water, the streams being swollen in November and February. The irrigations which consume expensive waters are those of April, May, July, August, and September, and last four months. Meadows for fattening pasture, the irrigation of which is suspended the first days of April, have a not less vigorous vegetation, because the manure which the beasts drop makes the shooting of the grass very precocious. An owner of such a meadow stated that the improvement produced by their manure was so great that the meadow gradually could do without other improvement and consequently without irrigations.

Meadows with a porous subsoil.—These meadows, as has been said, are always in valleys having a flat bottom and which are easily brought under water. Winter and autumn irrigations are naturally replaced by inundations from springs (*crues*) of the river.

The spring irrigations begin when, after the fountains cease to give out water, the soil tends to dry up—*i. e.* in April—as regards impervious meadows; but they last much longer. In fact, it is not enough that in these lands the ground remains moist, and that it is preserved by the grass from the action of the sun's rays; another cause—the porousness of the subsoil—tends also to dry it up. The irrigations of these meadows may then take place

when the ground is perfectly sheltered. In certain countries they irrigate till the last fortnight before the harvest, and when done with proper knowledge the irrigations do not sensibly change the quality of the grass.

The summer irrigations of the porous meadows of the Seine are made from the 10th of July to the 20th of September. The duration of those of spring and summer is about five months.

Meadows of granitic regions.—These are almost always on the slope and above the limit of the springs of the water-course. They may, like those on clayey soils, be irrigated in autumn and winter, when it does not freeze. The basis of this formation is light and burning, and dries up easily. The irrigations must therefore, as in porous soils, be carried on to the last fortnight before harvest.

Intermission or rotation in irrigations—Continued irrigations.—Irrigations are often continued in clayey soils, when a supply of water in the level trenches can be enjoyed, as may be desired, during the whole season of irrigation. The quantity of water absorbed is very small; in fact, as the soil is impervious, and mostly remaining moist, it does not absorb the enormous mass of water which, in intermitted irrigations, disappears in mole-holes, crevasses, &c.

In April, 1849, I gauged a stream which, near Avallon, irrigates nine hectares (about 23 acres) of excellent Lias meadows; its mean delivery during every month was only 1.37-100 litre per second, and a great portion reached the drain, (*colature.*)

We may make continued irrigations in granitic soil; but as the surface bed of that soil is very light and porous, such irrigations use up much water. I have seen near Avallon a meadow of ten ares absorb in the whole summer the product of a stream delivering two litres per second, without this enormous irrigation apppearing to injure the crop.

Intermittent irrigations.—These, on clayey meadows, are very different from those on porous meadows with a light soil. In the upper valley of the Seine there is no rule.

Meadows with impervious and clayey subsoils.—It has been seen that when it is drawn from a fountain or small stream, the irrigation is continued. The irrigations by rain-water are always regular and sufficient in autumn and winter, but in spring and summer they are very irregular; those of spring have the great inconvenience of taking place in a cold time, and are frequently followed by frosts. It is rarely that the rains are abundant enough to permit more than two irrigations from the 1st of April to the 15th of May. But in spite of this imperfection, these irrigations, when intelligently conducted, give good first cuttings. Summer irrigations are almost wholly wanting, and, for fear the soil may become dry, there is no second cutting. M. Rozat de Mandres showed me, on the valley of Ouanne, meadows of green grit, which are of great fertility, and which are irrigated only three times in spring and four times in summer. The inhabitants of the country say that these are more than enough, and even injure the quality of the grass.

It has been shown that in the liassic meadows of Avallonais and Nivernais, and in the green grit of the valley of Loing, two to three irrigations answer for the spring; in summer there ought to be only four.

These facts, though few, must be admitted for all clayey meadows, as meadows of this kind are very fertile without irrigations, and the continued irrigations of lias meadows, greatly multiplied in Nivernais, use far less water than those that are intermittent.

Meadows with porous subsoil.—The spring irrigations last from 22d of March to 20th of June, the summer ones from 24th of July to 23d of September. The time is regulated; the water is used wholly for irrigation, in spring and summer, on the Sabbath and festival days, from 7½ o'clock in the evening till 3 o'clock in the morning. It cannot be taken in autumn and winter, except from Saturday, 8½ o'clock in the evening, to Monday, 3 o'clock in the morning, and from Tuesday, 8½ o'clock in the evening, to Wednesday, 3 o'clock in the morning. Each part of the meadow cannot be irrigated more than twice a week. The draughts of water cannot be taken, except by sluices of a regular legal head. Every one exercises his privilege most vigorously, and irrigates his land twice a week in spring and summer, and once a week in autumn and winter. The intervals are, therefore, three and a half days in spring and summer, and seven days in autumn and winter. The crops are abundant. In the valley of Ource, the meadows of Villette yield 6,750 kilograms of hay at the first cutting and 3,000 kilograms of aftermath, and this sells for 10 francs more than others. The meadows are preserved from inundations by dikes. They irrigate in autumn and in the months of November and December, and during all winter. The frost of autumn and winter occasions them no trouble. But when the grass shoots, they carefully avoid irrigations in the time of frost. As the submersion is by means of sluices or feeders which bring on the water instantaneously, they do not fear to irrigate in March, when it does not freeze. This they continue during April and May, and do not cease until the grass is quite large, and there is danger that it may be lodged by the water on it. As they have the water at command, the intervals are irregular. They irrigate more or less abundantly, according to the degree of dryness that exists. In the winter they cannot keep it up con-

tinuously; in the spring, when the herbage is sprouting, they irrigate for some days, and then suspend, to recommence when it may be of advantage. They begin after haying, and continue till the crop of the aftermath. This meadow is very fertile. The mean crop is 5,000 to 5,500 kilograms (5½ to about 6⅝ tons) a hectare (2½ acres) for the crop, and 2,500 kilograms (2¾ tons) of aftermath of the first quality. The frequency of the irrigations here does not alter the quality of the grass.

It is clear from the above that the order of the irrigation of meadows with porous subsoil must be wholly different from that of impermeable ones; that the irrigations must be oftener renewed, (once a week, for example,) and, consequently, they may take place twenty times in the seasons of spring and summer.

When a meadow is accustomed to frequent irrigations, they must be kept up till haying, or the grass fed by water (as the farmers say) quickly withers, and cannot reach maturity. One case is mentioned of a whole crop lost by a suspension of irrigations for five or six days.

When, in a meadow with a porous subsoil, the irrigations are rarely renewed, they absorb much more water than otherwise. This must be the case, as the fissures of a dry soil, and the mole and mice holes, conduct the water to the subsoil, which absorbs it. It is very important, therefore, not to allow too long intervals of the irrigations.

Of the quantity of water necessary to a hectare, (2½ acres,) M. Nadault de Buffon gives 9,600 cubic meters for spring irrigations.

There are also *meadows, with a subsoil and soil of clay*, which can do without irrigation. Such are some in Bray of Normandy, composed of clayey or clay-sandy soils, which are very fertile. So, too, those on the waters of the Auge, and very little is required in the pastures of Orne and the Sarthe. This great vigor of the vegetation is not to be attributed to the moist climate of Normandy, for the *chalky* meadows of the same country require most abundant watering.

Almost all the meadows of the Higher Seine are of this kind. Let us try to determine the quantity of water absorbed in each kind of soil by regular irrigations, assuming that the rotation of the irrigations is so fixed that the ground is never wholly dry.

Meadows with a clayey soil and subsoil.—The *lias* meadows of the Higher Seine are never irrigated at regular intervals. The watering is irregular, when it is done with rain-water; it is continued with the water of springs or small streams. In determining the quantity of water used, one of the best meadows is selected. In this meadow, near Avallon, of nine hectares, the delivery of water is 1.37-100 litre per second, and the quantity of water used by these nine hectares during four months of spring and summer, or 10,400,000 seconds, is 14,248 cubic meters, or, per hectare, 1,583 cubic meters. Divided into six intermitted irrigations, it gives 264 cubic meters per hectare.

M. Rozat de Mandres found that a good irrigation of meadows of green grit could be had with a bed of water varying from 0.0278-10000 meter to 0.031115-100000 meter in thickness.

Meadows with a porous subsoil.—The irrigations on these meadows are very irregular, and no estimates have been procured. In Normandy, on the river Arve, with few springs, its mean delivery in the warm season is three meters per second, and it irrigates 1,000 hectares.

Spring and summer irrigations.—These last twenty-two weeks, and absorb the whole river for sixty-nine hours a week; thus there are 16,394,400 cubic meters of water used. Each portion may have two irrigations a week, in all forty-four irrigations in spring and summer. Each of the 1,000 hectares is then irrigated, and covered at each irrigation with a quantity of water expressed by 16.394400-44000 = 372 cubic meters.

From the excess of the irrigations of the valley of the Arve, the soil is always moist, even at haying, so that the first irrigation of spring does not use much more water than the others.

It is a fact which seems to follow from the whole of these experiences, and justified by reasoning, that in a meadow irrigated sufficiently, and which is kept in a state of freshness, so that the heat will not produce any fissure, the quantity of water used at each irrigation, excepting the first one of spring, ought not to vary much, whatever be the nature of the subsoil.

In fact the surface of a meadow is too compact, too little movable for the action of the subsoil to make itself felt with much energy on water coming in large quantity, and which only, so to speak, glides upon the surface. Thus it is seen above, that the quantity dispensed by each irrigation per hectare varies from 278 cubic meters (Experiences of M. de Rozat) to 372. (Irrigation of the Arve.)

M. Nadault de Buffon admits that a moderate irrigation requires only 400 cubic meters per hectare; the number of irrigations varies greatly, as above shown, by irrigations of rain-water on liassic meadows; and the experiences of M. Rozat, that 6 irrigations suffice for two cuttings of clayey meadows, while in fact 44 at the same time are given in the porous valley of the Arve.

Indeed, from the observations of M. Nadault, 20 irrigations in porous soils produce a better effect, and ought to be regarded as the best limit in Central France.

The following summary presents a comparative view of the subject:

Nature of the soil of the meadows.	Volume of water used.		No. of irrigations.	Total volume of water used during the time of spring and summer irrigations.
	By irrigation of the 1st of June.	By each of the other irrigations.		
Meadows with clayey subsoil	2,000	400	6	4,000
Granitic meadows	2,000	400	20	9,600
Meadows with porous subsoil—bottoms of valleys	2,000	400	20	9,600

The quantity of water, then, necessary for clayey meadows at the maximum, is two-fifths of that necessary for other meadows.

In general the quantity necessary for the irrigation of a clayey meadow during a dry season is between 0. and 4,000 cubic meters.

The maximum of M. Nadault (15,000 cubic meters) is much exceeded, as he himself admits, and says that these excessive irrigations must destroy the meadows where they are used. But M. de Foltz does not agree to this, as according to him those meadows which have been subjected to a continuous irrigation of 70 to 100 litres per second and per hectare give in three cuttings 7,500 kilograms of excellent hay.

Nor is all the water absorbed. M. de Foltz states that the greater portion of it enters the Moselle by the drains, so that with a delivery of 12 meters per second the river is sufficient and more so for the irrigation of 830 hectares of grit meadows. Thus 14.50-100 litres are absorbed per second per hectare, allowing the river to be dry at the grit, but it is probable that it is not dry where it reaches that point.

In the 20th volume of the second series of the *Annales des Ponts*, &c., there are some statement srespecting the various canals used for irrigation in the Arrondissement of Avignon.

There are five of them: Canals of *turbid* water, derived from the Durance. 1. Canal de Cabedan Neuf et de Plan Oriental; 2. Canal Saint Julien; 3. Canal Crillon; 4. Canal de la Durancole, or the Hospices d'Avignon; 5. Canal of M. de Cambis.

The Canal of St. Julien.—The supply canal is 2,400 meters from the bank of the Durance to the security dams. The maximum in the canal, from the 1st of April to the 5th of October, is 4.69-100 meters, viz: for St. Julien, 3.51-100 cubic meters; for Cabedan, 1.18-100 meter.

The length of the canal of St. Julien is:

	Meters.
From the inlet to the distribution sluices	2,400
From that point to the Torrent of Coulon	6,800
Thence to the Trench of Mourgon, at Caumont	5,000
Canal of Cabedan Vieux, from the dams of the Torrent of Coulon	5,000
Canal of Fugneirolles, on the right bank of the Coulon	3,000
Total	28,700

The fall in profile of the canal of St. Julien is between 0.0003-10000 and 0.001-1000 meter per meter. The quantity that can be watered in the communes of Cavaillon, Cheval, Blanc and Taillade, is 2,950 hectares, (7,375 acres.)

The quantity annually irrigated is 1,890.50-100 hectares, (4,726.25-100 acres.) The number of persons having an interest in this canal of irrigation is 2,060. The price of irrigation per annum is ten to twelve francs per hectare.

The fall in profile of the canal of Cabedan Neuf is from 0.00025-100000 to 0.001-1000 meter.

	Meters.
The length of the canal of Cabedan Neuf is	19,700
That of the Plan Oriental	5,500

The number of hectares in the two is 1,196.66-100, (2,930 acres,) which is divided among 1,150 proprietors. The quantity of land irrigated in 1848 was 747.02-100 hectares, (1,367 acres.) The price of irrigation 24.79-100 francs per hectare.

The canal of Crillon, in length 14,700 meters, is between the Durance and the Rhone. The fall in profile varies from 0.0002-10000 to 0.0008-10000 meter per meter. It is also cut by three falls of six meters. The length of its distribution trenches is 14,000 meters. The legal delivery is two cubic meters; the actual delivery two to three meters. The surface irrigated is 650 hectares, (1,625 acres,) divided between 750 proprietors. The price of irrigation is 24.44-100 francs per hectare. There are one-sixth gratuitous; another sixth only pay 17.58-100 francs.

The canal of Durancole, or of the Hospices d'Avignon:

	Meters.
Length from the mill of Caumont to the canal of Hospices	7,000
Canal of Hospices from the inlet to the Rhone	10,000
	17,000

The number of proprietors is 630. The price is for 385.50-100 hectares 14.05-100 francs; for 481 hectares 19.91-100 francs per hectare, and 352 hectares are gratuitous.

Irrigations with clear water.—Canal of Vaucluse, &c.—The irrigations by the fountain of Vaucluse are very considerable.

	Hectares by water let on.	Hectares by wheels.
Branche de l'Isle et Canal de Vaucluse	1438.00	10.00
Branches de Velleron	2050.00	11.50
Branches diverses	74.00	2.50
	3562.00	24.00
	3,886.00	

The price of irrigation of the canal of Vaucluse is 3.50-100 francs per hectare.

RECAPITULATION.

Irrigations of turbid water.

	Delivery.		Normal price of irrigation in francs.	Number of owners.	Number of hectares irrigable.	Number of hectares actually irrigated annually.
	Legal.	Actual.				
Canal of Cabedan Neuf	1.73	2.75	27.00	1,150	1196.66	747.02
Canal of St. Julien	1.73	4.69	11.00	2,060	3247.75	1890.50
Canal of Crillon	2.00	4.69	23.44	750	2000.00	650.00
Canal of Durancole	2.00	1.60	19.91	530	1118.50	840.00
Canal of M. de Cambis	2.00	1.62	23.44	4	1200.00	27.00
Canal of Camprambaud	2.00	0.07	12.92	95	67.81	67.81
Irrigations of clear water.						
Fountain of Vaucluse	2.00	13.00	3.50	5,000	3586.00	3586.00
Communes de Courthezon et de Bedamides	2.00	13.00	4.65	55	184.27	103.20
Projected canals.						
The Canal of the Association de l'Isle	2.00	2.00	16.00	3,000	2500.00	2000.00
The Canal de Carpentras	4.00	4.00	25.00	7,000	5000.00	4000 00

The following results are also gathered from the same tables in detail:

Irrigation by the waters of the Durance.

	Thickness of the veil of water in meters, &c.	Quantity of water per second and per hectare in litres.	Manure in value annually in cubic meters.	Manure in money value in francs, &c.	Quantity of hay per hectare.				Cost in francs.	Product.
					1st cut.	2d cut.	3d cut.	Total.		
Total 41 days..	0.34	6.266	240.00	2476.00	37.8	27.8	14.6	80.2	440.00	5902.00
Mean 6.83.....	0.0567	1.044	40.00	412.17	6.3	4.63	2.43	13.37	73.33	983.67
Irrigation of meadows by clear water.										
Total 21 days..	0.17	2.811	171.00	1710.00	14.3	11.6	4.4	30.3	200.00	2021.00
Mean 7 days...	0.0567	0.937	42.75	427.75	4.767	38.67	1.467	10.1	66.07	673.67

The expense and product per hectare:

	Francs.
Cost per hectare	2,550
Total product	13,350
Mean per hectare	4,450
Deduct cost	2,550
Net profit	1,900

The quantity of water necessary for a hectare.—Association of the Canal of St. Julien.—The whole number of hectares is 2,950, requiring a little more than 0.85-100 litre per hectare.

The relative value of the lands, irrigable or otherwise, is given as for the irrigable 15,000 francs per hectare to 4,000 francs not so. Many of these canals ought, however, to irrigate a greater area of meadows. Thus the canal of Crillon, instead of 650 hectares, ought to water 2,000 hectares. The canal of M. de Cambis, instead of 30, 1,000 hectares.

The volumes from which these statements have been drawn contain likewise many other interesting remarks, but they would occupy more space than can be given to them.

In Belgium the canals of irrigation are under the direction of the government, and the rules for their management, or Police des Irrigations, are very definite, as appears from some of the papers issuing from the Minister of the Interior. The minimum of the outlet flow in the Canal de Maestricht is given at two meters, ten centimes, (about as many yards.) When the water reaches to a centimeter the irrigation is suspended.

In no country of Europe has irrigation, as an aid of agriculture, been carried forward on so extensive a scale, nor with better results, than in Italy. The whole of the plains of Lombardy and of Piedmont, as well as other portions of the present Sardinian realm, have been intersected and covered with canals of larger or smaller size, distributing feeders, and the different constructions necessary to render them effective. Men of science have been employed to determine the questions as to the amount of water required, and the mode of sending it out, so that the most economical use may be secured, while a sufficiency may at the same time be allowed, both to the great proprietors and to the small farmers. Their legislation is likewise regarded as the most complete for the purpose by all who have been commissioned by different governments to examine into this question.

Fortunately we have the report of a full investigation into the whole subject from R. Baird Smith, esq., of the Royal Bengal Engineers, who was sent out to Italy by the East India Company to ascertain the character of the works constructed and the practical results, with reference to extensive comparison and improvements of the canals of irrigation in India. His work is contained in two volumes, octavo, with a large folio atlas, and is filled with a great variety of details which his peculiar facilities as an accredited agent connected with the English government enabled him to collect. It is, probably, hardly known in this country, never having been republished, and a summary of its facts may hence be read with

interest in connexion with these remarks. The author gives his information as he derived it by his visits in succession to the different portions of Italy. It will be seen by some of the statements that the Italian canals are not used exclusively for the purposes of irrigation. They also furnish means of transportation and travel, and often water power for carrying mills of various kinds, the tolls on which contribute to their support and give a revenue.

Of the great canal of the Ticino, in Lombardy, Mr. Smith says, that it is an artificial river, constructed as early as the twelfth century, and bears onward a volume of water nearly equal to one thousand eight hundred cubic feet per second. This great mass of water has been spread over the surface of the country by a thousand channels, and has made the region through which it passes one of the richest and most densely populated the world has ever seen.

The Cavo Marocca furnishes two hundred cubic feet of water per second. It is one hundred and fifty miles long, and its cost was £1,600 ($8,000) per mile; while the repairs and maintenance are about £20 to £25 ($100 to $125) per mile a year. The total superficial irrigated region here may be estimated at 2,500 square miles, or 1,750,000 acres. The slopes range from about five to twelve feet a mile; the velocity of the rivers is considerable; the river beds are strong and compact, and, being of gravel and boulders, withstand all the erosive action of the waters. More than twenty-seven thousand cubic feet are so discharged per second. The irrigating season commences in March and terminates in September. The months when the water is in the greatest demand are May, June, July, and August; the mean temperature is about 72° Fahrenheit, and the ordinary maximum 82° 32′. The mean height of the thermometer, when exposed to the sun, is 91° 47′. The average annual fall of rain is given as thirty-seven inches, of which twenty-eight inches fall during the seven irrigating months. There were seventy-one rainy days, allowing an average of four-sevenths of an inch a day. The number of days marked perfectly clear or cloudy was just double those on which rain fell.

The date of the most ancient of the canals of Piedmont reaches back to the fourteenth century. The most active period of this canal system was in the feudal eras of the fourteenth and fifteenth centuries. The energies, both of the State and of individual proprietors, have been brought out for these works of utility. At first the administration of them was rude and imperfect, especially as regards the distribution of the water. Every man supplied himself as he wished; but about 1474 there was adopted a rude plan for measuring out the waters of the canal of Ivrea; and, since then, by slow and halting steps, the advances have gone forward till precision has been given by the adoption of a standard or metrical module, which is in general use at the present day.

The canals of the Dora were constructed principally for the use of the royal domain; that of the Veneria Reale, the most important of them, was made in 1750. It yields in summer seventy cubic feet of water per second; its length is only eight miles, and it irrigates about five hundred acres of meadows. The charge for the water is from 2*s.* to 2*s.* 6*d.* (about forty or fifty cents) per acre. The canal of the Royal Park is two and a half miles long, and yields two hundred cubic feet of water per second. With it is connected a small canal of supply one mile in length, having ninety cubic feet per second. The extent of the irrigation is two hundred and fifty acres. Another canal is that of Fiano; its principal channel is ten miles long, with forty-eight cubic inches of water per second in summer, and twenty-four in winter; and it waters nine hundred and fifty acres. A branch canal for the Veneria Reale, from the river Stura, is five miles long, with a summer volume of twelve cubic feet per second, and in winter eight cubic feet per second; it waters two hundred acres.

The first work of great importance in the irrigation system of Piedmont is the canal of Caluso, from the left bank of the Orco. It was begun in 1556, and completed in 1560, at which time the government became the proprietor. In 1760 two tunnels were made in connexion with it, one nearly 2,300, the other 2,400 feet long, with a common section of about eleven feet broad and twenty-seven feet high. In the beginning of the present century the discharge of the canal of Caluso was equal to 366.26 cubic feet per second, sufficient to irrigate 18,000 acres, if the waters were economized; but it did not actually water more than 15,000 acres. It is twenty miles in length. Its mean breadth at the bottom is eighteen feet, at the surface of the water twenty-six feet; its mean depth below the level of the country six and a half feet, giving an average depth of three and a half feet, and covering an area by its channel and banks of fifty-four and a quarter acres. The natural fall of the water being adopted gives it great irregularity. The fall of the channel is about 338.08 feet; so that it has a general slope of nearly seventeen feet in a mile, which is ten times more than it ought to have, and the loss of power is equal to 10,000 horses. In the minor channels of more modern times the slope is only twenty-four to thirty inches per mile. There are on it not less than fifty-nine bridges, twenty-six aqueducts, and above 36,000 feet of masonry revetment, besides planking. Its bed is paved with stone for more than 21,000 feet. Its average cost per mile was £1,700 (or $8,500.) Mr. Smith states, by way of comparison, that the Grand Canal of the Ganges, in India, with a volume nearly

twenty times as large, cost not half the amount; and that the Western Jumna, with a discharge eight times as great, cost not more than one-eighth as much; while the Eastern Jumna, the most expensive of the canals of British India, with a volume twice as great, cost only one-third as much. The canal channel of Caluso is capable of carrying four hundred and seventy cubic feet per second, but the summer maximum is only four hundred and forty feet in the greatest heat. Not more than 349.35 cubic feet of this is secured for irrigation, the rest being lost by filtration, evaporation, &c. A cubic foot a second is capable of irrigating 19.214-1000 acres, but actually waters only 17.955-1000 acres. The price of the water from 1760 to 1800 was about 2*s.* 10*d.* to 3*s.* 7*d.* (sixty to eighty cents) per acre; at present it is nearly 3*s.* (seventy-five cents) per acre.

The length of the canals of the Dora, Stura, and Orco is forty-nine and a half miles. Their discharge in cubic feet per second is 769.5 The areas irrigated 19,855 acres.

The canal of Ivrea, from the Dora Baltea, was begun in 1468, and then abandoned in 1564, and reopened in 1654. It is 44.64-100 miles long. Its greatest mean breadth is 27.7 feet, least mean breadth 17.68 feet. The slope of its bed is not less than four to five and a half feet per mile. It has a volume of seven hundred cubic feet per second in the season of summer irrigation, and in winter of two hundred and forty cubic feet per second. The area of land which it irrigates is 30,000 acres, or at the rate of forty-two and two-thirds acres per cubic foot per second. The rice meadows are said to require double the quantity of the ordinary meadows. The average price of water is 8*s.* per acre for a cubic foot per second. From the main line there are a number of minor canals for distributing the water. Of these six give two hundred and seventy-two cubic feet per second, making in all forty and a half miles long, with a greatest mean breadth of fifteen feet, and the least 7.07 feet. The channels from various springs which are feeders to the canal are fourteen and a half miles long; so that, in all, the canal of Ivrea, with its branches and feeders, is 99.64 miles long. The main line has twenty bridges in masonry, eight aqueducts and four escapes, and numerous irrigation outlets. Another, seventeen miles long, has twenty-three bridges and seven outlets; and the same constructions are found in the other branches and minor channels—at least one bridge for a mile of channel, and generally more.

The canal of Cigliano (from 1783 to 1790) is twenty miles long, fifteen to twenty six and a half feet broad; has a branch ten miles long, with a mean breadth of sixteen feet; is four feet deep, and yields sixty cubic feet of water per second. On both there are fifty bridges and thirteen aqueducts, and the discharge is six hundred and fifty cubic feet per second, with an area of irrigation of 32,500 acres, equal to fifty acres per cubic foot. The price of water is 8*s.* per acre, and for rice land 10*s.* to 16*s.* per acre.

The Canal del Rotto, begun in 1400, is, in its main line, eight miles long, with a breadth of 24.18 and depth of 6.84 feet. It has two branches; the first is twenty-two and a half miles in length, with a mean breadth of eighteen feet, and a discharge of one hundred and twenty-two cubic feet per second; the other, (in 1838,) eighteen miles long, with a mean breadth of fourteen feet, and a volume of sixty cubic feet a second. The discharge of the main canal is six hundred cubic feet per second. The total area of irrigation is 25,000 acres, giving fifty-five acres for a cubic foot per second. The total discharge, therefore, of the canals of the Dora Battea per second is 2,600 cubic feet, and the area of irrigation amounts to 115,500 acres.

Another canal of Piedmont is that of Gattinara, from the Sesia, eight miles long, with a volume of about one hundred cubic feet per second, and then dividing into two parts, the Gattinara and the Cavo; the length of the Gattinara in all being fifteen miles, with a mean breadth of twelve feet; and of the Cavo seven and three-quarter miles, with a mean breadth of six and a quarter feet; thus giving a total length in all of twenty-two and three-quarter miles. The extent of land irrigated is about 4,500 acres, or at the rate of forty-five acres a cubic foot per second. The canal of Roggia and Mora (1481) has a total length of thirty-two and a half miles, with a breadth of twenty to twenty-six feet, discharges four hundred and fifty to five hundred cubic feet per second, and irrigates 7,000 acres. A second Gattinara, its branch, is two and a half miles long, and waters 1,250 acres, the discharge being twenty-two and a half cubic feet per second. The canal of the Roggia Busca, in length eighteen miles, volume three hundred and fifty cubic feet per second, irrigates 6,915 acres, or one hundred and six acres per cubic foot. Its total length, with its branches, is thirty-nine and a quarter miles, with a main breadth of twenty feet; and its distribution channels are four to ten feet in width. The canal of Rizzo and Biraga is seventeen miles long, volume ninety cubic feet per second, irrigates 9,052.98 acres, or 100.6 acres per cubic foot per second. With its branches, its length is eighty-eight and a quarter miles. The canal of Sartirana has nineteen branches, sixty and a half miles long—the main being eighteen miles in length, discharging 220.38 cubic feet per second, and irrigating about 13,680 acres, or sixty-three acres per cubic foot. The price of water is nearly 20*s.* per acre. The whole series of the canals of the Sesia is two hundred and twenty-five and a half miles long, with six hundred and twenty-seven and a half cubic feet per second, and irrigating 41,333.78 acres.

Others mentioned are the canals of the Agogna, 13.73 miles long, volume two hundred and twenty-two cubic feet per second, irrigating 20,132.2 acres, or an average of 90.6 acres per cubic foot, at the rate of 7*s.* 9*d.* per acre; the canals from the Arbogna, thirteen and a quarter miles long, volume 18.02 cubic feet per second, at the rate of 14*s.* per acre; the canals of the Terdoppio, thirty-five miles long, volume 135.2 cubic feet per second, irrigating 7,884.5 acres, being an average of 55.4 acres per cubic foot—the price of the water 12*s.* 9*d.* The sum total of the above minor streams is one hundred and twenty-six miles and a quarter long, watering 28,506.95 acres, with a volume of 375.54 cubic feet per second, thus giving seventy acres average per cubic foot, at 9*s.* per acre. Adding all its branches, the canals of the Sesia and branches give a total of three hundred and seventy-three miles in length, a volume of 1,003.42 cubic feet per second, with a surface irrigated of 71,090.28 acres, or 68.6 acres per cubic foot.

On the right bank of the Ticino are enumerated the canal of Langosio, twenty-seven miles long, with minor channels of forty-eight miles—total length seventy-five miles; having a discharge of 249.06 cubic feet per second, and an area of irrigation of 19,142.5 acres, or seventy-seven acres per cubic foot, at a price of 11*s.* per acre; the canal of Sforzesca, (begun in 1842,) its entire length thirty-seven miles, discharge 215.95 cubic feet per second, area of irrigation 14,878 acres, or sixty-nine acres per cubic foot, price of water 18*s.* per acre. There are also three others, respectively, three and a half, four and a quarter, and four and a half miles long, with volumes of 25.39, 114.32, and 24.90 cubic feet per second, irrigating 2,483, 9,125, and 2,040 acres, or an average of 99.3, 80.4, 81.6 acres per cubic foot. From springs in the districts of Mortara and Novara there are canals four hundred and sixty-seven and a half miles long, with a volume of seven hundred and eighty-eight cubic feet per second, and which water 52,500 acres. The canals of the Ticino are, therefore, equal to six hundred and twenty-seven and a quarter miles in length, and discharge 1,417.62 cubic feet per second, watering an area of 100,168 acres.

On the right bank of the Po are several canals: 1st. Of the Stura, (1678,) 9 miles long, with a mean breadth of 15 feet, a volume of 80 cubic feet per second. 2d. Di Bia, 8 miles long; mean breadth, 18 feet. 3d. Naviglio di Bia, 20 miles long; mean breadth, 20 feet; waters 5,500 acres; the price of the water is 3*s.* 6*d.* per acre. 4th. Of Pertusuta, 8 miles long, 15 feet broad; volume, 96 cubic feet per second; waters 4,000 acres. 5th. Soprano, discharges 70 cubic feet per second. There is likewise the canal of Charles Albert, from the Bormida. Its whole cost was £42,000, or £2,800 per mile. It is 15 miles long, with a mean breadth of 16½ feet, and a depth of 6 feet from the surface of the soil. It discharges 80 cubic feet per second, and the price of water is 9*s.* per acre. In the hilly region of Piedmont not less than 2,500 cubic feet of water per second are rendered available for irrigation, and the extent watered is 180,000 acres. The whole irrigated region of Piedmont is 1,500,000 acres; the amount of cultivated or cultured land in plain is 890,454 acres; the total of actually irrigated land is 306,613 acres. The total quantity of water utilized in Piedmont is 8,290.54 cubic feet per second, and the area is covered by a network of canals more than 1,200 miles long.

The same great system of irrigation also prevails in Lombardy. The entire area of the country, including the province of Verona, contains 9,350 square miles, or 6,000,000 acres. Of this only 561 square miles is sterile. The areas of the basins and irrigating rivers include 9,427 square miles, and the discharge of water is equal to 30,727.45 cubic feet per second. The water is in the greatest demand here from May to August, and the mean temperature is then 70° to 75° Fahrenheit, with a maximum of 85° to 90°. The annual fall of rain in the irrigated districts is 36 inches, or nearly 22 inches during the period of irrigation. Of the principal canals mentioned the following may be named:

1. The Naviglio Grande, 31 miles long. It is subject to great irregularities. The breadth varies from 75 to 160 feet; its depth 4½ to 15 feet. In the first portion of 9½ miles, the slope is from 3.75 to 7.75 feet in a mile; in the second, of 14½ miles, its breadth is from 60 to 80 feet, depth 3.25 to 3.75 feet, with a slope of from 1 to 5.7 feet per mile. The last portion, of 7 miles, has a breadth of from 40 to 50 feet, a depth of 3.84 to 8.16 feet, with a slope of 2.84 feet per mile. The total fall in 31.02 miles is 108.03 feet, or an average of 3.05 feet per mile. 2. The great dam of the Paladella is 918.47 feet long, and 31 to 58.33 feet broad, except 120 feet, which is only 7.84 feet broad. The canal has 6 weirs, 12 escapes, with 185 sluices of from 2½ to 2¾ feet breadth. The discharge is 1,851 cubic feet of water per second. The loss on the whole canal is 158.25 cubic feet per second, or nearly 5 cubic feet per second in a mile. The area irrigated by it is 93,440 acres in summer, and 1.750 in winter; so that the summer irrigation is 61.8 acres per cubic foot. The price of the water for the summer is 4*s.* to 4*s.* 3*d.*; in winter 17*s.* per acre. 3. The canal of Bereguardo is 11.35 miles long, with a fall, including its locks, of 88.66 feet. It has a mean breadth of 35 feet, its breadth varying to 40 or 45 feet. The height of the water is from 5.76 feet in summer to 3.84 feet in winter. The quantity of water discharged is 156 cubic feet per second, distri-

buted from 18 outlets; 12 of which absorb 76.35 cubic feet, and 6 others 79.65 cubic feet per second. It irrigates 10,400 acres, at the rate of 66.6 acres per cubic foot, or, in winter, of 138 cubic feet per second. 4. The canal of Pavia discharges 215 cubic feet per second, being 20.7 miles long, with a fall, including locks, of 184.05 feet. Its breadth at the water line is 35.36; at the level of the top of the banks, 38 feet. Its cost was £296,875, or £14,800 per mile. The extent of its irrigation in summer is 9,550 acres, or 69 acres per cubic foot; and in winter 294 acres, or 1.3 acres per cubic foot.

Of the canals from the other streams of the Milanese, that from the Olona irrigates 2,395 acres in summer and 50 acres in winter; from the Lambro 15,286 acres in summer, 350 in winter; from other streams, 2,000 acres in summer, 250 in winter. The canals of the Ticino, &c., are 62 miles long, with 163 irrigating outlets, a discharge of 2,460 cubic feet per second, and the area of irrigation 131,571 acres, or 70.4 acres per cubic foot.

The canals of the Adda are:

1. The canal of Muza, 37.37 miles long, with a fall of 227.89 feet, or of 64 feet per mile. Its discharge of water is 2,175 cubic feet per second; of which 477 cubic feet per second is lost by evaporation, equal to 13½ cubic feet per mile. The distribution is by 75 outlets, and the price per acre is only *3d.* The area irrigated is 182,500 acres, or 89.9 acres per cubic foot. Besides, in winter, there are also 2,750 acres of winter meadow, at the rate of 1.27 acres per cubic foot. Mr. Smith compares with this the canal of Jumna, whose volume is equal to the Muza, and which is ten times as long, and has an irrigation area five times as large, with 670 outlets; also the Ganges canal, three times the volume of the Muza; its area of irrigation eight times as large, and thirty times as long. 2. The canal of Martesana is 20.66 miles long, with a fall of 54.93 feet, or 2.03 feet per mile, discharging in summer 843 cubic feet per second, and in winter 687½ cubic feet. The wastage is 105 cubic feet per second, leaving 738 cubic feet per second for use. The canal Martesana, combined with the Naviglio Interao, has a discharge of 876 cubic feet per second, and irrigates in summer 58,900 acres, and in winter 1,150 acres; or in summer 67.2 acres per cubic foot, and in winter 1.3 acre per cubic foot. The price of the water in summer is *3s. 6d.* per cubic foot. The total amount of irrigation in the Milanese, in summer, is 470,971 acres; in winter, 7,837 acres. The whole cultivable area is 520,000 acres; so that nine-tenths of this cultivable area is irrigated.

The canals of the Adda, in Lombardy, also deserve notice. The total volume of water from these is 3,633 cubic feet per second. The area of irrigation in summer is 241,400 acres, or 75.55 acres per cubic foot. On the left bank of the Adda and right bank of the Oglio are the canal of Adda, with a discharge of 414 cubic feet per second, irrigating 38,000 acres, or 92.7 acres per cubic foot; the Brembo, with a volume of 296 cubic feet per second, watering an area of 27,425 acres, or 91.45 acres per cubic foot; and the Seria, with a volume of 501 cubic feet per second, irrigating 44,200 acres, at an average rate per cubic foot of 88.2 acres. The Oglio has a volume of 1,372½ cubic feet per second, and an area of irrigation of 142,500 acres, equal to 101.3 acres per cubic foot—giving for the above, on the left bank of the Adda and right bank of the Oglio, a total area of 291,779 acres. The whole cultivable area of this district is 1,400,000 acres; so that one-fifth of this is irrigated.

On the left bank of the Oglio, the canal of Oglio, with a volume of 1,522½ cubic feet per second, irrigates 136,432 acres, or 89.04 acres per cubic foot; the canal of Mella, discharging 429 cubic feet per second, irrigates 36,300 acres, being 85.1 acres per cubic foot; that of the Chisio, with a volume of 828 cubic feet per second, irrigates 72,750 acres, being 90.4 acres per cubic foot; the Fossa di Pozzolo of the Mincio, with a volume of 510 cubic feet per second, waters 20,500 acres, averaging 40.2 acres per cubic foot. The small rivers also irrigate 8,000 or 9,000 acres more. These give a total of 298,542 acres. The whole cultivable area of this district is 1,953,973 acres, about one-tenth of which is thus irrigated. The sum, therefore, of the statement for Lombardy, is a total area of 6,500,000 acres, of which there are irrigated in summer 1,061,292 acres, in winter 12,837 acres; in all, 1,074,129 acres, or about one-sixth of the whole, or one-fifth of the productive, area. The great government canals in Lombardy are 133 miles long. Besides the main lines there are 353 branches, and probably a network of 3,550 miles. East of the Adda they reach 700 or 800 miles; thus making the entire length of the canals of Lombardy 4,500 miles. The discharge of water amounts to 15,118 cubic feet per second, while the whole amount of the discharge of rivers, &c., is 30,000 cubic feet per second. In the entire valley of the Po, Piedmont and Lombardy, there is an extent of irrigation of 1,600,000 acres, or nearly 24,000 cubic feet per second, at £250 per cubic foot, giving, as stated, an increased rental of £830,000 per annum. This detailed view of the canals of Piedmont and Lombardy will serve to show to what a wide extent irrigation was carried at the time of the examination. It is not improbable that since then the system has been still further developed.

Besides the canals from rivers, there are likewise channels of irrigation derived from *fontanelli*, or irrigating springs. One of these, about two miles from Milan, has a head

formed by an excavation 200 feet long, 100 feet wide, and 8 feet deep. The water-bearing stratum is here reached, and there are no less than 42 separate springs, each enclosed in its separate case, throwing their small supplies into the main reservoir. The united discharge is 12 cubic feet per second; and it is worth £4,000, or $20,000. Some of the wooden tubes are eight feet in diameter; and to sink them twelve feet in hard gravelly soil required five months' daily labor. One flows half a mile, reaches an ordinary surface, and then irrigates 30 acres of fine marcite or winter meadows; ten cubic feet are left for use at lower levels. The spring is an ordinary one, and one-seventh of the water is lost by absorption and evaporation.

It is to Italy that other European governments seem to have turned their attention for information on a variety of questions that need to be answered in carrying out any extensive system of irrigation. Existing, and undergoing modifications for so many centuries, the bearings of its various relations are there understood. Numerous volumes are mentioned as having been published on particular portions of the subject. It early became a matter of no little interest in conducting these operations to fix the principles on which the distribution of water might be conducted, so that the rights of every one entitled to a share might be equitably adjusted. Regulations of various kinds, of course, had to be adopted.

One of these points was to settle the unit of measure. This is called the *modulo* or *module*, in Sardinia; in Modena, the *macina;* the *ruota*, in Piedmont; and *rodigine*, in Lombardy; also sometimes the *oncia*. It is "that quantity of water which, under simple pressure and with a free fall, issues from a rectangular quadrilateral opening, so placed that two of its sides shall be vertical. The outlet shall have the breadth of two decimeters (7.874-1000 inches) and a height of two decimeters. It shall be opened in a thin wall (plate or *parete*) against which the water stands, with its upper surface perfectly free, at a constant height of four decimeters (15.748-1000 inches) above the lower edge of the outlet." This is the standard module. The macina of Modena is that quantity of water which is sufficient to turn the wheel of a corn-mill. In Parma the outlet is usually 12 inches in height and 9 in breadth. The ruota of Piedmont and rodigine of Lombardy will discharge nearly twelve cubic feet per second. The oncia is in height 6.72 inches, breadth 5.04 inches, having a pressure of 3.36 inches, and discharges 0.85 cubic feet per second. The discharge of the modulo, the height, breadth, and head of pressure above the upper edge of the outlet, being each equal to 7.874 inches, is 2.04 cubic feet per second, the only varying dimension being the breadth, according to the number of the modules included. Thus two modules have a breadth of 15.748 inches; three modules, 23.622; and so on. Many problems are given for the application of these measures in the varying circumstances in which the use of water is required.

The conditions essential to the practical working of a good system of measurement are thus stated by Brunacci, who is regarded as a high authority in these matters:

"In order that the two orifices in two separate reservoirs, maintained constantly full, should discharge equal quantities of water in equal times, it is necessary, first, that the two orifices should have exactly the same area, the same form, and especially the same perimeter or circumference; second, that they should be placed at the same depth beneath the surface of the water; third, that the plates or partitions in which the orifices are cut should have the same thickness; fourth, that the water in both reservoirs should be equally calm or equally disturbed on its surface, or throughout its mass, in the vicinity of the orifices; fifth, that the directions in which the water passes through both orifices should be the same; sixth, that the water, if not stagnant, should arrive at the orifices with the same velocity; seventh, that the discharge of the water from the orifices should be equally free or equally checked: that is, if canals are attached to the outlets, they should have equal sections, slopes, or other conditions; eighth, that if the discharge is made in water the result should be the same."

The results sought to be obtained are the following: "1. That, wherever placed, outlets nominally of equal discharge should always furnish, in given times, exactly the same quantities of water. 2. That the discharges should be equal, however the level of the canal of supply may vary. 3. The measuring apparatus should be so constructed as to render it impossible for its proprietors, or any other person whatsoever, to alter in any way its discharge, without leaving traces of such attempts easy to be recognized. 4. That the manner of working the apparatus should be so simple as to require no more than the most ordinary intelligence on the part of the officials intrusted with its regulation, so as to avoid all risk of its being injured either by their awkwardness or ignorance. 5. That no calculation should be necessary in regulating its discharges; but when alterations in the quantity of water were necessary they should be made at once by the mere adjustment of the measuring apparatus. 6. The apparatus should occupy but a limited space, so as to admit of its being applied in all localities. 7. The normal discharge, or unity of measure, being once determined, the apparatus ought to be so constructed as to insure constancy of volume from large and small outlets."

"These seven conditions being exactly fulfilled, the problem of a measure of water perfectly adapted to the most extensively adopted system of irrigation will be solved; and this the *modulo magistrale* of Milan has effected."

On investigating the phenomena attending the discharge of water under these circum stances, the early Italian experimentalists found:

"1. There was established between the two compartments of the reservoir a constant difference of level, and that this difference was proportionally greater, according as the opening of the discharge was less in comparison with that of the outlet. 2. That if, instead of maintaining the level of the water in the reservoir constant, it was subjected to elevations and depressions, the variations corresponding to these were found to continue proportional to the heights respectively for a given condition of the orifices of discharge and communication; or, in other words, if, when the level in the reservoir was maintained constant, the heights of water in the two compartments were to each other as three to one; then a depression of the level of the first compartment to the extent of say three feet would produce in the second a depression of one foot—eighteen inches in the first, six inches in the second, and so on. 3. That this principle was not affected by the employment of two or more partitions—*i. e.*, the same relative proportion was maintained between the variations of level and the original heights of water in the first and last compartments whatever addition was made to the number of the immediate diaphragms."

"The *oncia magistrale*, or unit of measure, (as in the case of the modulo, though with slight variations of figures,) is that quantity of water which flows freely, or under the sole influence of pressure, through a regular opening having a uniform height of four local inches, (7.86 English inches,) a breadth of three local inches, (4.12 English inches,) and a constant pressure of two local inches (3.93 English inches) above the upper edge of the outlet. When several water inches are to be discharged by one outlet, the breadth only varies three local linear inches (4.12 English inches) for each additional water inch, the pressure remaining constant. Horary rotation is also adopted for the measurement of water in some cases. This varies between seven and sixteen days, rarely, except in the case of rice irrigation, falling below the former or passing beyond the latter amount. Numerous specific rules and problems are given, illustrating the application of the standard, according to the exigencies supposed, by means of which all the questions arising in irrigation may easily be determined.

"No Italian sluice is ordinarily more than about four feet in width, the depth being variable, dependent on the maximum supply, rarely, however, more than five feet. One man, in a few minutes, opens a gate which carries 500 cubic feet of water per second. In the construction of their canals, the Piedmontese employ artificial stones, called *prisme*, which are prismatic masses of conglomerate, made of hydraulic lime and small gravel, the masses so made being three feet long, the side of an equilateral triangle forming the prism, being 15 inches."

In the arrangements respecting the use of the water, the government disposed of the absolute property to the proprietors of the soil. This had a beneficial effect, as there was an inducement to invest money in such purchases. "As soon as the water passed beyond the banks of the government canal, the purchasers had unrestricted liberty to dispose of it; the *dirotto di acquedotto* (or right of passage) secured to every proprietor of water the power of conveying his channel, under certain specified conditions, across all lands intervening between the main canal and his own property; and when the supply was greater than his immediate wants, he could dispose of the surplus to his neighbors. This covered the whole country with a network of small canals, which were rarely, perhaps, directly profitable to those who originally constructed them. The outlay was large, and, at first, the direct returns would hardly pay the interest on the capital. It is the indirect returns—the improvement of the soil and the power of bettering their cultivation—to which the proprietors look for compensation."

"Three kinds of lease are adopted by the proprietors. The first, called *Affitto in denaro*, is a money rent. This prevails on such large irrigated farms as require a constant superintendence of well-qualified men who have capital. The tenant pays a fixed sum annually, in one or more payments, and he is to make specified additions and improvements. Before he enters on his possession, an elaborate statistical survey is made, and a valuation of fixtures, &c. This is called the *Consegna*, and in it every field is separately and minutely described—its position, the canals, &c., and the plantations are numbered tree by tree. At the close of the lease, which is from nine to eighteen years, if the plantations have decreased in value, the tenant is debited, if increased, credited. A new survey is now made, called a *Re-consegna*. The two surveys are compared and a balance-sheet is struck, called *Bilancio*, and the tenant must pay or receive from his landlord, according to the state of the farm."

"The second method is the *Affitto a mezzadria*, which is a division of profits of nearly equal

shares. The proprietor is to deliver over the farm in an efficient state for culture, at his own expense carry on certain operations, such as planting trees or pruning them, laying out new plantations, breaking up lands, &c. The cultivator has to perform the whole labor, pay half the public burdens, supply half the wood for vineyards and half the seed, pay a certain rent for the house, supply small quantities of straw, and give his labor, when needed, at a certain rate fixed in the contract. The produce of the kitchen garden is the cultivator's; of the woods and meadows, the proprietor's. The whole of the product is to be delivered at the proprietor's granaries, where the cultivator is to receive credit for half the value, or the proportion agreed on.

"The third method is the *Affitto a grano*, in which the cultivator is bound to deliver a fixed rate of wheat, from fourteen to twenty bushels per acre under cultivation. All the rest of the products of the soil is his own. The products of the plantations of vines, mulberries, &c., belong to the proprietor, who gives the cultivator credit for half the value. Two-thirds of the cultivated farm is generally devoted to wheat, while on the other third he raises Indian corn."

The principal revenue of the canals used for irrigation in Italy is not in the direct returns made for this application of the waters. The indirect returns, in the increased value of the crops, are of more material benefit. Some items as to the cost, expenditures, &c., in the case of the canals already mentioned, will show how this matter stands. The annual repairs of the canal of Caluso are about £300, and the salaries about £200, or £25 per mile a year. The amount of expenditure for the canals of the Dora, Stura, and Orco is stated to be £692, of the net income, £1,371. The annual expenditures of the canal of the Ivrea are, for repairs, £1,291 13*s*., for salaries, £290; in all, £1,580. The total income is £6,000, leaving thus a net income of £4,420. The indirect returns are estimated at about £18,000 per annum.

The income of the canal of Cigliano is £5,205 per annum; the expenses £420, or £14 per mile. The indirect benefits are from £19,000 to £20,000 per annum. The annual income of the Canal del Rotto is £5,000; its expenses £625, giving thus a net income of £4,375; while the indirect benefits are at least £15,000 per annum. The annual income of the canals of the Dora Baltea is £14,000; its annual costs £2,625. The indirect returns are £69,800. The revenue of the canal of Gattinara is from £3,000 to £3,500 per annum; of the Roggia Mora, with its branch, £1,000 to £1,250 per annum. The annual income of the canal of the Sartirana is £3,500. The indirect return of the canal of the Sesia and its branches is £42,734. The net revenue of the canal of Sforzesca is £1,500 per annum. The revenue of the canals from springs in Novara and Mortara is stated to be £30,000 per annum. The annual indirect returns of the canals of the Ticino are £60,001. The net revenue of the Naviglio di Bia, which cost £1,000 per mile, is £550 per annum; that of the Ptusula £625.

The addition to the rental of the Piedmont canals is estimated to be £290,000, with direct returns also of £25,000; and so of Lombardy. While the government revenue from the Naviglio Grande is only £1,796 15*s*., the addition to the rental of landed proprietors by means of it, in irrigation, is given at £60,000 per annum. The annual expenditure of the canal of Bereguardo is £1,700; the income, direct or indirect, is not mentioned; but as it waters some 10,400 acres, it is no doubt considerable. The canal of Pavia cost £296,875, or £14,800 per mile; its income is £3,000, and the cost of repairs, &c., as reported, was £1,400, yielding in direct returns only the half of one per cent. The annual direct returns of the canals of the Ticino, &c., are large, viz: £84,078.

The canals of the Adda are stated to add £140,000 per annum to the agricultural rental, while those of the Oglio give a similar addition of £150,000 per annum.

The whole annual increase throughout the Milanese, by means of these canals of irrigation, is £270,000, and in the other provinces £290,000, making £560,000, which represents a capital of £14,000,000. In 700 years the expenditure has been £40,000,000 for 1,900,000 acres, and in the entire valley of the Po, Piedmont, and Lombarby, there has been an increased rental of £830,000 per annum.

The results herein stated are, of course, more or less defective, being based on reports of different years; but, from the whole investigation, the conclusion must be drawn that, though admitting of increase, the canals of irrigation have been of immense benefit to those regions where they have been carried into successful operation. Another fact evincing this is the comparative increase of population in the irrigated districts. Thus, while the population of the irrigated districts of Piedmont averaged but 269.5 per square mile, and of the unirrigated 313.26 per square mile, the progressive increase in the twelve years between 1819 and 1832 is, for the irrigated districts, an average of 0.278 per cent., while for the unirrigated districts it is only 0.174 per cent.

The effect of irrigation in Italy is seen in its application to cultivated lands bearing crops of grain; but the information in respect to meadow lands is the most full. These are

divided into two classes, permanent and temporary, or such as are introduced into the rotation of crops in their place. The permanent meadows are of two kinds, viz: summer and winter. The permanent summer meadows are under irrigation from the end of March to the middle of September. For permanent or temporary summer meadows the general principles here practiced are few and simple:

"1. It is essential that the surface shall readily receive the water from the main channel. This is effected by taking advantage of the natural inequalities, so as to deliver the water from the culminating line. These are to be lowered or raised as needed. In one place, near Milan, over an extensive area, the excavation and raising the ground ranges from three to five feet. 2. The water must be spread in a thin uniform sheet over the surface. This is secured by gently inclined planes of the soil. These planes or beds, (*ala*,) in light and absorptive lands, are from 25 to 30 feet broad; in heavy and retentive soil, eight or ten times this breadth. In Lodi the breadth in the direction of the slope is 140 meters, or nearly 460 feet, and the length across the slope 180 meters, or 590 feet, so that each bed is thus eight English acres. To each there is a main irrigating channel three feet wide. In summer meadows it is not usual to have minor channels, unless special circumstances require them. The slope to the meadow surface, when practicable, is two-tenths per 100, or three inches in each 100 feet English. 3. There must be ready means of drainage to prevent stagnation. For this purpose there is a drainage channel along the base of the slope parallel to the main irrigating channel, and thus the surplus water is collected and carried off, or rendered available at a lower level. These drainage or surplus waters are regarded as the most important. As they pass over rich lands, they become charged with fertilizing matter. Their temperature is also higher, and they thus prove a powerful stimulant for the grass. The divisions should correspond to the general features of the face of the country in their slope. In Italy they run from north to south, and the irrigating channels from east to west. In reference to the produce, these meadows are cut thrice in the year. The first cutting is in May, and is called Maygengo; the second is in July—the Agostano; the third at the end of August or the beginning of September—Terzuolo. The grass after this, called Quartirola, is given up to pasturage to the end of autumn. In some cases, however, there are four crops."

The total crop of hay in the three cuttings is given as 56.775-1000 cwt. per acre.

"On the temporary summer meadows there is usually a rotation of five years, viz: first year, wheat, which is cut in the middle of July, grass seed being sown with the wheat; second, third, and fourth, meadow under irrigation and abundantly manured; fifth, Indian corn or flax. After the flax is cut, at the end of June, millet is sown, which ripens at the end of October."

As to the quantity of water to be given meadow land, there are three ways of estimating it: "1, by the volume of water in the continual discharge required for a given area of land; 2, by the entire depth of the water spread over the soil at each watering, or during the whole season of irrigation; 3, by the total cubic contents of the mass of water employed."

"According to De Rigi, an eminent authority, the continued discharge of a cubic foot per second is enough to irrigate four acres in 24 hours. Hence, as the total volume in this time is equal to 86,400 cubic inches, and the area 174,240 square feet, a stratum of water six inches deep was spread over the meadow. In 14 days' rotation, therefore, a discharge of a cubic foot per second would irrigate 48 acres, there being 12 periods of fourteen days in the whole season of summer irrigation. This is true if the whole of the water is absorbed by the soil; but this is not the case. The absorption in each watering is from one-half to one-third of the entire quantity. Hence, allowing one-half of it, one-half of one cubic foot per second would answer for 48 acres. The irrigating power of any given quantity of water is held to be equal to twice the area watered in the first application of the water. Therefore, one cubic foot of water would irrigate 96 acres of permanent or temporary meadows; or, one cubic foot is sufficient for the irrigation in the ordinary rotation of 38 acres only; or, if we take into the account the surplus water, twice this quantity, and so 76 acres in the whole."

"Todini, who is high authority, says that a mass of water equal to 35,000 cubic feet is enough for an area of 107,100 square feet, with a stratum of three and a half inches at each watering, or a power of cubic feet equal to about 96 acres. The conclusion, therefore, is safe that a stratum four inches deep, leaving half the water in the soil and the other half being carried off for further use, will answer. Of course, a variety of soil will make a difference. The soil of Italy is sometimes of a light sandy nature; in other places dense clay; and elsewhere gravel also; but generally it is light and fertile where the water is used. In the Mortara and Vignano districts the soil was arid; or when heavy, retaining water and forming pestilential marshes, almost waste. There was no regular culture; the population was scanty and poor, and their industry and internal commerce languishing. Now, as irrigated, it has become richly productive and one of the most densely populated

regions in Europe. Instead of arid wastes and great marshes, cornfields, green meadows, or rice grounds are seen."

"The *Marcite*, or winter meadow irrigation, is an interesting branch of this subject in Italy. The winter irrigation of Italy is from 12,000 to 15,000 acres. The right to water for it begins on the 8th of September and ends on the 25th of March. There must be an entire command over the water to be successful, as irrigation at intermissions will not answer. The only suspension is when the grass is cut. The water must be of as high a temperature as possible. On the 14th of February, 1822, Signor Berra, in his work on the subject, gives it as +10.5 Reaumur, while the general temperature of canals is about —1.5 Reaumur, a difference of 27°Fahrenheit."

In the marcite, or winter meadows, the land is disposed in a series of small ridges or valleys. On the crest is a small channel, supplied with water from the irrigation main. The water pours over the spaces (*ale* or wings) in a thin and constantly moving veil. It is received into the drainage canals which are formed at the bottoms of the little valleys, and is carried away and, at a lower level, gathered into the general watercourse to become further available in the irrigation of other fields. The slopes or wings are generally about 30 feet broad in the centre, 10 or 12 feet high, and raised at the crest 12 inches, having a breadth there of about 3 feet. These are the general proportions, though they vary sometimes as to height and breadth. The earth from the irrigating or drainage channels is spread over the slopes or planes with great dexterity, so as to give them the requisite slope; and when this is done they are ready for irrigation. Another ploughing and harrowing is given, and the land is left untouched till the end of February. The sowing is in April. The small drainage channels are not made till after the seed is sown, when they are easily made, as they are only nine inches broad and six inches deep. The outlay for winter meadows is estimated at £3 7*s.* 6*d.* (about $16 or $17) per acre. The quantity of water required is very great. One cubic foot per second is only enough for three and a half acres. If the meadow is seven acres there is needed six cubic feet per second, of which the surplus is four and a half feet, so that one and a half feet is absorbed. The constant passage of the water over the roots of the grass stimulates the growth; the moving mass also carries over a rich portion of the humus of the soil, so that it is an exhaustive process, and this renders it necessary to manure the marcite meadows, which is usually done twice a year. Five crops of grass are generally obtained on them in a year. To prepare them costs £10 or £12 ($50 or $60) per acre; and, in some cases, the expense rises to £40 or £50 per acre. The net value of the annual produce per acre is about £6 ($30). The yield per annum is given as being—

	Cwt.
For the first cutting, in February	84
For the second cutting, March to April	126
For the third cutting, April to May	131.25
For the fourth cutting, May to July	75.5
For the fifth cutting, July to September	63
	479.75

or nearly 24 tons of grass hay.

Others, near Milan, give twice this quantity, as they are cut in November, January, March, and April, for stable feeding; and in June, July, and August give three crops of hay, with abundant pasturage for September. They thus give seven crops in a year, and the ordinary yield is 45 to 50 tons, with half as much more in remarkable cases. Thirty-five acres of the ordinary marcite meadows will yield a sufficient supply of hay for the maintenance during the year of 50 cows, stall fed, except in September and October, when they are turned out to pasture; 20 acres are enough to supply grass for seven months, and 15 more for hay for the three winter months. The following is a statement of the expenses and returns, with the accruing profit of 50 cows on 20 acres, under treatment as marcite meadows:

	£	*s.*	*d.*	
Expenses	91	9	10	
Returns	314	9	6	
Total profits	222	19	8,	about $1,115,

or £11 2*s.* 11¾*d.* (about $55 75) per acre. Should the proprietor not own the water, we must deduct £5, or $25, per acre, *i. e.*, $500, leaving $615 for the 20 acres, or $30 75 per acre profit. The produce of lands surrounding the irrigated lands is at the same time estimated at $6 40 per acre. The rent, therefore, from such irrigated lands is $24 35 per acre.

A larger amount of water is, of course, required for the irrigation of rice in Italy. According to the Italian authorities, one cubic foot per second is sufficient for the irrigation of from

35 to 40 acres of rice, being 45 to 50 cubic feet per acre. In the Milanese it is held that land under rice absorbs a stratum of water 47 inches deep every 24 hours, or almost two inches an hour. In Verona and Malta it is double this quantity; in the South of France 0.663 of an inch. In the North of Italy and Centre of France the daily evaporation is between .78 and .117 of an inch, while in the South, and with hot winds, it is between .156 and .196 of an inch. If the average daily loss by evaporation is .180 of an inch, we have for supplying the plants and loss of filtration a stratum .473 of an inch deep. Hence a continued discharge of 45 to 50 cubic inches of water per second is enough for one acre of rice land, supplying a daily stratum of a depth of between .62 and .68 inches. It has been found in Italy that a slightly increased velocity of water passing over a meadow under irrigation compensates for the deficiency of heat. In marcite meadows this is a consideration of importance, as the high temperature of the water and the peculiar disposition of the soil, with the results on the stream irrigating, seem to be the chief points in this kind of cultivation. The snow does not lie on these fields, nor is the thin veil of water liable to freeze, unless the frosts are quite severe.

Situated as Italy is, and with such an extensive system of canals and channels for the distribution of water over the fields, the *legislation* in respect to irrigation is likewise a subject of interest.

The early provisions of the law allowed any one who had a right to water "to carry it through the fields and farms of any individual, commune, or corporation, and also across the public roads;" likewise to "construct the canals or channels and other necessary works at the least possible inconvenience and injury to the proprietors of the farms, paying one-fourth more than the true value of the land occupied." But "he must repair all damages caused by the works, according to the estimate of two practical men," "the compensation not to exceed twice the value of the property damaged." He was further made "to maintain in efficient repair, and at his own expense, the bridges and drains required for the passage of the water, whether on farms or across the roads, so that these latter shall suffer no injury, especially in rainy weather." He could conduct the water above or below previous canals, making new channels of brick and lime, such that "the water flowing under shall not be mixed with that flowing over or within the pre-existing canals;" which new channels he must maintain in such a manner "that the proprietor of the water at the upper levels shall suffer no damage from the reflux of the same." The water was to have "a free and unobstructed course." The right of passage was thus guaranteed, and also the exercise of it restrained from being oppressive to individuals. In other words, the principles of the system, as it has gradually become developed, are now: 1. The right of passage; 2. The limitation of this right to lines which shall occasion the least inconvenience to others; 3. Payment for the land occupied a fraction above its true value, one-fourth generally; 4. Compensation for damages, which shall not exceed twice the true value of the damaged property; 5. An obligation on the proprietor of the water to keep the channel free of hindrances to its flow. In the law of Verona "every inhabitant" was at liberty to take as much water as he needed to irrigate his property, after having obtained a grant from the proper authority, on condition of inflicting no injury on those who hold older rights. He could also demand passage, &c., by paying for twice the land so occupied. This price was to be fixed by skillful men, chosen by the parties interested; the payment to be made in advance, unless the proprietor, by special contract, chose to allow a delay. On such conditions the sale of the land became obligatory, and was to be effected by a legal act. In case of a refusal, the magistrate (*podesta*) was to adopt compulsory measures to put him in possession, according to law. The possession thus obtained was held to be good and admissible as regarded the grantee. If the proprietor refused to receive the price so fixed, the money was then to be deposited with the authorities; and as soon as this was done the works could be begun. If there existed any difference as to the location of the channel, the professional men employed were to select that place which was the least injurious to the property. Similar regulations were made as to all disputes regarding channels previously sanctioned. In case of the intersection of another canal or water course, the passage was to be made above or below the existing one by means of suitable works, and security for damages must be deposited before the canal or works were begun. In case this had been done the proprietor of the land could not hinder the execution of the works, but must lend all practicable assistance; and the settlement for damages was to be made on the completion of the work. In case a new watercourse caused a marked decrease of the extent or value of the property, the party who claimed the right of passage was not only bound to pay for all injury as estimated, but also to purchase the entire property of the owner, if he desired it to be done. The provision of the payment in advance, and especially this latter stringent one, requiring the purchase of the entire property, was peculiar to the law of Verona.

According to the law of Piedmont the compensation for soil is fixed at only one-eighth more than the true value. Proprietors of pre-existing canals are bound to permit their use for new supplies unless they can prove that it would be injurious to their interests to do so;

and all parties who avail themselves of the right of passage, but who neglect their duties, are to be fined ten crowns, besides damages. There are also numerous provisions as to the terms of grants and enforcement of rights, the measurement of water, the general administration and police for taking care of the canals, &c.; likewise for the adjustment of disputes, repairs, enlargements, recovery of expenditure, &c. The whole subject has been most thoroughly studied and applied in minute detail. It no doubt admits of improvement; but, so far as appears from the statements, the legislation has not only been exact, but wise. Cases are mentioned in which a wealthy litigious proprietor has sacrificed his interests for years rather than yield for the benefit of others; but this is no more than is found in every country, and in respect to every species of property.

A complete sketch of Italian irrigation has been given, because, from its long existence and the accumulated experience by which, in a variety of particulars, it has enriched other countries, much may be learned even for our own, however differently situated. With a full knowledge of what has been done elsewhere, we are better prepared to carry out any improvement ourselves.

Before proceeding to sketch the progress of irrigation elsewhere, it may be well to glance at its success in India, as it was in this connexion the valuable information respecting Italian irrigation was brought out to the public, Captain R. Baird Smith being relied upon for important details: "A system of irrigation is nowhere conducted on so grand a scale as in this part of the British empire. Some of the canals are like mighty rivers, and a vast extent of country receives the benefit of their waters for agricultural purposes. The first canal dates back to the fourteenth century. The principal canals in India are those on the river Jumna West, of the Eastern Jumna, of the Sutlej, and of the Ganges. The whole length of the main lines of the Western Jumna canal is 445 miles. The total area of the country traversed is 3,784,385 acres. Of this the irrigated portion is 859,902 acres. In one district one-half, in another one-third, and in the great sterile tract of Hissar one-tenth is brought under the influence of the canals. These irrigated areas include all the villages using canal waters for different purposes; but of the land actually watered there are only 357,501 acres. The proportions of the irrigated area to the land actually watered in various districts are as 1 to 0.37, 1 to 0.4, 1 to 0.36, 1 to 0.49. The best watered district is the irrigated portion of Hissar, the chief towns of which, in 1807, were literally without an inhabitant, and in which the canal has called forth an active and thriving peasantry. The entire cost, including repairs, of the Western Jumna canal was only £119,474. But not till 1833–'34 did the income cover the expenditure. The amount of water rent from 1820 was £351,753. The gross value in 1837 and 1838 on irrigated lands—the greater part would have otherwise been wholly unproductive—as given for the crops of the rainy season, including sugar-cane, indigo, cotton, and rice, was £405,176; and for the crops of the cold season, as wheat, barley, &c., £957,000; in all, £1,461,276; so that nearly £1,500,000 was saved by the canal, of which one-tenth, or £150,000, was paid to the government as land rental; the remainder supported during a famine five hundred villages. The returns of 1837–'38 to the government covered the whole cost of the canal, and left a surplus of nearly £26,800. Including other returns, the account stood thus: the total expenditure was £353,660 16*s.*; the revenue amounted to £420,607 2*s.*, leaving a surplus of £66,946 6*s.* The annual increase of the land revenue due to the canals of the Western Jumna is stated to be £29,436, and there has been added to the direct canal revenue £60,000 per annum, leaving a net income of £43,000, which, on the capital invested, gave 36 per cent. The excess of population is likewise very great on the irrigated above the unirrigated, being two-fifths larger."

The Eastern Jumna has a system of distribution canals measuring 500 miles. The area of the land so watered is 160,000 acres. The proportion of the irrigated district to the unirrigated is, for the unirrigated, 2,759,526 acres; irrigated, 421,875 acres; in particular districts being respectively 1 to 0.19, 1 to 0.11, 1 to 0.25. The proportion of the irrigated to the actually watered is, for the irrigated, 421,875 acres; for the actually watered, 106,705; and the proportion in certain districts is 1 to 0.2, 1 to 0.25, 1 to 0.32, or one-fifth, one-fourth, one-third of the total areas. The total annual revenue of water rent from 1836 to 1846–'47 was £109,316 6*s.* The gross value of the crops on irrigated land, which otherwise would have been unproductive, including the rain crops and those for the cold season, was £488,494 6*s.*, almost half a million, of which one-tenth was government revenue. The total expenditure was £197,442. The annual increase of land revenue due to the Eastern Jumna canal is stated at £14,965. Adding to this the direct revenue of the canal, it is £27,000. The expenditure was £81,460; current expenses, £8,000; net annual income, £19,500; yielding thus, on the capital of £81,460, nearly 24 per cent.

The Sutlej canal discharges a volume of 2,500 cubic feet a second, and waters an area of 312,000 acres. Its effect is shown in the increased land revenue of £24,321, or £33 per square mile. The direct returns were £55,521 on a capital laid out of £250,000, or 22 per cent. The total gross value of the crops from the irrigation was £1,488,500.

The Ganges canal has a total length of 898½ miles. The cultivated area of the Doab is 8,255,255 acres; the cultivable, 2,846,793 acres. The actually watered portion in the whole is stated to be, for that thus benefitted by the Eastern Jumna, &c., 1,500,000 acres; by the Ganges, 4,500,000; from wells, &c., 900,000, or nearly one-half of the irrigable land of the Doab. The direct returns were £163,850 per annum; increase of land revenue, £239,040, making £402,890. The net revenue on the capital of £1,500,000 amounts to £350,000, or 23⅓ per cent. The gross value of the crops on irrigated land not otherwise productive was £7,653,125, of which one-tenth was returned to the government. The excess of the crops of the irrigated lands above those of the unirrigated was, for wheat, 530 pounds per acre; for barley, 730 pounds per acre; giving an average of 630 pounds per acre, or on the whole crop 480,000,000 pounds, or 4,000,000 quarters of grain, which, at 3*s.* per quarter, amounts to £600,000 per annum. Thus the total increase of the produce, £1,200,000 per annum, is almost equal to the entire capital. Well irrigation, which has to give way to canal irrigation, is thirteen times more expensive, and the saving to the agricultural community by canal irrigation is shown to be two and a half millions pounds sterling per annum.

In summing up the benefits to be derived from the Grand Ganges canal, the following are enumerated: "It will add to the revenue £350,000 per annum, protect from the risk of famine upwards of 11,000,000 acres, inhabited by 6,500,000 souls, paying to the state £1,800,000." In the event of the failure of rains, it will save agricultural property to the amount of £7,500,000, and add to the increase of produce £1,200,000 per annum. Compared with other modes of irrigation, it will prove a saving of £2,500,000 annually. In respect to the system of irrigation between the Ganges and the Sutlej, it is said that "when all the works are fully developed the agriculture on which about 12,000,000 souls depend will be secured; produce which cannot be valued at less than £10,000,000 per annum will be placed beyond the contingencies of the season, and the public revenue of £3,000,000 yearly protected from fluctuation."

Besides the canal irrigation, tank embankments are used in India, the object of which is to water land in their rear. One of these, of which there are one hundred and twelve, is 7,955 feet long. They have a total spread of water of 13,086 acres, in which the area of cultivation is equal to 9,794 acres.

Allusion has been made to the introduction and practice by the Moors of irrigation in Spain. In the years 1816–'19, M. Jaubert De Passa, of France, visited that country and examined the state of the various public works and of the legislation on this subject; and the result of his researches is given in two volumes. M. Hericart de Thury, on behalf of the committee of irrigation, at the public session of the Royal and Central Society of Agriculture in France, in 1822, then presided over by M. le Compte De Corbiere, Minister of the Interior, speaks in terms of warm commendation respecting M. De Passa's labors, and says: "The researches of M. Jaubert De Passa form a complete treatise, we may even say an entire code of legislation, on the course of water and irrigation in the principality of Catalonia and the kingdom of Valencia. They compose two volumes in folio, the first of six hundred and eighty-four pages of text, nearly all from the hand of the author; the second, a very valuable summary of the public acts relative to the grand canals of the kingdom of Valencia." The work thus mentioned was revised and presented to the public in the shape of two volumes, from which will be extracted a variety of particulars which may help the reader to form some proper estimate of the irrigated surface of Spain, and of the influence of the practice there. Forty years have passed since the researches were made, yet it is not doubted that there has been an advance rather than otherwise; so that the condition of that country is now even more favorable in these respects than it was then. Commencing with the principality of Catalonia, M. De Passa notices everywhere a diversity in respect to the progress of husbandry. Frequently, he says, beside a rich cultivated valley, because some unknown benefactor has endowed it with a canal of irrigation, we may meet with new valleys left to barrenness, though at a very slight effort of a powerful hand a neighboring stream might be directed upon those unproductive lands. There is a large number of canals of irrigation in the higher valleys of Catalonia, even up to the very gorges of the Pyrenees. These allay the heat of the sun and force the ground to yield several crops in a season. But these local resources are limited; a few men, scattered over a wide space, enjoy them, and they exercise no influence on the countries adjoining. The author had not for his object a general history of the canals, but a bird's-eye view, as it were, of some of the most prominent of them. Speaking of the river Ter, which, taking its rise in the mountains of Catalonia, comes down on the plains of Ampurdan, M. De Passa expresses his surprise that the facilities it affords have not been improved, as they should be, to water extensive tracts of country which he describes. Of the Canal de Girone, which is fed by the Ter, he states that it irrigates only small slips of land; yet the use of the water is not without abuse. This canal is the property of the city; its mean breadth is about four meters (or somewhat over twelve feet); its elevation three meters, or nine feet. It traverses many tracts of land, intersected by rapid streams; and to prevent damage by these it has been necessary to build many weirs

and bridges. The water sometimes rises to the height of nine feet, and much of it is often lost which could be applied to the purposes of agriculture. The lands irrigated are in two divisions, and are farmed out for about one hundred and thirty-four francs (or about $26) per bassane, a surface of ground on which one sows three double décalitres (nearly two bushels) of wheat; that is, about twenty-five ares, or half an acre.

M. De Passa states that the *Noria*, a wheel with buckets, which was brought into Spain by the Moors, furnishes daily a great volume of water for irrigation. It is moved by one horse; the water is collected into a large basin, whence, by means of trenches, oftentimes made with mason-work, it is conducted to the beds in the garden or field. The buckets of the noria are earthen; they do not raise above one hundred and twenty-five cubic inches of water each, but the motion of the wheel, and the number of buckets, which are so placed that five turn over at once, are sufficient to exhaust a very large spring. It is an economical apparatus, as often a hectare (about two and a half acres) of land and one noria are sufficient, in a burning clime and on sandy ground, to sustain a numerous family, and even prove a source of income to the fortunate small proprietor. Some of them are operated by sails, like a windmill; in this case substituting a pump for the buckets. The regularity of the wind, an advantage not enjoyed in many countries, affords the means of using this contrivance here as cannot be done elsewhere.

At Barcelona there is a canal of irrigation which receives its waters from the Besos, and is divided into a vast number of small canals, watering all parts of the land. Much skill is shown in thus turning to good account the impetuous stream; and the effect of the irrigation is said to be to make the whole basin a real garden.

Of the canal of the Lobregat, M. De Passa says its construction had many obstacles to encounter. It was necessary to convince every proprietor that his interest required a sacrifice of a part of his property, and that additional funds ought to be supplied; to arrange the reciprocal services needed for the construction of numerous feeders; to reconcile the jarring, claims amid a diversity of interests, and to establish barriers and weirs, and carry the canal along difficult slopes, or across ravines; and to provide against the effect of a movable soil. Happily all this was done under the direction of the Captain General Castaños, so that the inhabitants on the left bank of the canal of Lobregat call it the Castaños canal. It irrigates 5,500 *mojadas*, (about 6,600 acres,) or more than an area of a square league. The quantity of water is estimated at 900 cubic inches per minute. A basin is constructed behind the causeway; five principal sluices serve to lead out the water of irrigation to the great canal, and there are two more for the discharge of the excess into the river, in aid of a secondary canal. The works are most solidly formed, and even sometimes with beauty; the sluices are managed with ease, turning by the strength of one man; and the care of the waters is well provided for. The distribution of the water into the canal is carried on daily, and at the same hours. Tables are prepared indicating to each proprietor his share, his privileges, and the restrictions imposed. It is bridged in many places, as it crosses numerous roads. The canal of Lobregat is about 20,000 yards (over 10 miles) long. Its breadth varies from three to five yards; the mean height of the water is about 4½ feet; the fall is about six inches in 1,000 yards; five principal branches receive the waters of the great canal, and, united, have a course of about 14 miles; thus making the whole about 25 miles. The expense of construction was about 800,000 francs ($160,000.) Another canal for the irrigation of lands on the right bank of the Lobregat was in contemplation at the time of M. De Passa's visit. Above the Lobregat is the canal of Manresa, the formation of which is attributed to the Romans, though it probably owes its origin to the Moors. M. De Passa mentions also the irrigations by *Norias de bara* of a somewhat different construction from those already noticed. On the plain of Tarragona there are two canals from the Fraveoli, a small stream which, in the course of nine leagues, waters a tract of more than 3,000 acres, that would otherwise be barren. By means of the canals about 700 acres are irrigated. The lands are said to be rendered very fertile, yielding rich crops. The irrigations of the Ebro, through the canal of Tortosa, have accomplished much; and the wheat and other products exhibit the benefits realized by this addition to the agricultural resources of that section of the country.

After giving a brief account of the canal of San Carlos, M. De Passa proceeds to the canal of Urgel, a much larger work. Its length is about 24 leagues, or 72 miles, and it waters 50 square leagues, or 150 square miles of country. This canal, in the dry season, can furnish in 24 hours 22,291,000 cubic feet of water; and estimating the loss by evaporation and infiltration at five per cent. there remain 21,176,450 cubic feet, which, dispersed according to the needs of the soil, at the rate of three inches of water in height for every inch surface that can be watered, as the maximum, gives about 1,680 acres every twenty-four hours; this, multiplied by 44, the number of days in which it runs between the two irrigations into the basin of the Urgel, we have 70,000 acres; and this added to the portion which represents the lands in repose, or merely ploughed after two harvests in succession, it

is shown that the irrigation can act on 110,924 acres of land. Three irrigations are required for wheat in Urgel; one in October, the time of sowing it; another in January or February, at the time when the vegetation seems to receive an unexpected increase of strength; the last in April, when it blossoms. By the above calculations it will be seen that the land sown with wheat could be more frequently watered; and, by more regard to the economy of water, the gain might be applied with great advantage to the irrigation of the forage plants.

Another canal, to complete the irrigation of the plain, is mentioned as on the Segre. It runs through the territory of Camarasa, and joins the secondary branches of the great canal, which are designed to water the extended valley called Rivière de Sio. The cost of the two principal canals, and seven intermediary branches, is given as 19,623,024 francs ($3,924,604.) Four canals, constructed by the Moors, on the two sides of the Segre, are also mentioned as rendering great benefits to the tracts of country bordering upon them. One of these is seven leagues in length.

In the kingdom of Valencia M. De Passa finds some works connected with irrigation which command his admiration. Here are also *norias.* He mentions those particularly of Vinaróz and Benicarló, and says it is on these fertilized rocks of Benicarló that we witness the prodigies which agricultural industry can effect when not deterred by obstacles. Here the numerous little streams direct the waters on a light bed of earth, which is naturally inert, but which the cultivator reanimates by means of improvements. The richest vegetation embellishes the soil reclaimed from its sterility, and the benefits of irrigation are not limited to the tract on which it is directed.

The first glance at the valley of the Vinaróz and Benicarló would lead one to suppose that a grand canal of irrigation, directed by a powerful and able hand, overcoming all obstacles, was spreading the tribute of its waters even up to the banks of the Cenia; but we vainly seek, in the midst of the cultivated lands, the traces of such a canal. Less important works have been sufficient to change the nature of the soil. Patient and earnest men, by their continued efforts, have succeeded in piercing the immense banks of stone in search of water in the bosom of the earth, and bringing it to the surface by the aid of five or six hundred *norias.* Each one of those ingenious machines is in the neighborhood of a farm; and the multitude of hamlets scattered over the fields, encircled by fruit trees, give an enchanting aspect to that part of the valley. The water is caused to remain in great basins, in order to subject it to the influence of the atmosphere; and, later, it is spread over the ground with all the celerity which necessity and the economy of labor demand. In a moment it floods the wide furrows of the wheat field, or the square beds, varied as the products to be raised on them. The principal feeders, firmly constructed, carry it without loss toward all those rich, chequered squares. Every irrigation revives the earth, promotes vegetation, and assures to the cultivator crops which are often of extraordinary magnitude. The effect is also seen in the calling out of a laborious and industrious population, even the women and children bearing their part in watching the *norias.*

Among other works deserving special notice in Valencia, M. de Passa was struck particularly by the manner in which the canal of Almazora and Castellon is conducted over the *rambla* (or torrent) of the Viuda. No permanent construction could resist the rapidity and immense volume of the waters which descend from the neighboring mountains during the season of the rains or storms. Any movable dike or temporary barrier would have been costly, as deep excavations must be made at great expense, and the bed of the river raised to bring it to the level of the canal; but a very simple and ingenious plan has been adopted to overcome the obstacle. A deep basin receives the waters of the canal as they leave the first gallery. They reach there by a high fall, and are immediately lost in a large siphon opened beneath the bed of the river, the outlet of which is 119 varas (about 110 yards further on. There they escape, bubbling and foaming, after having passed with incredible rapidity into that conduit. To give an idea of the force of the current, it is sufficient to say that a stone of several pounds weight runs quickly through that mysterious passage, and almost immediately appears at the outlet. As measured by M. de Passa, by means of a stone at the end of a cord dropped in at the opening and carried through the length of this conduit, it is about 170 yards. Different aqueducts, at large cost, are likewise described, the works of former times, as well as numerous regulations restricting the distribution of the waters. He passes over with a mere mention several canals of irrigation, and dwells rather on those which are fed by the Guadalaviar. Here twenty *acequias,* or canals, serve for the irrigation of the lands on the sides of the river, to an extent of more than 20 leagues (60 miles.) There are three others in connexion with the Pedrava, and still eight more, which absorb all the waters of the river and turn off the excess, if there be any, into the meadows or strips of land bordering the river. The whole quantity of water in these eight canals is given as 138 *filas;* that of the first twenty as 164 *filas.* Our author finds considerable difficulty in settling the precise meaning of this term, as there is a difference of opinion respecting it. Some say it is an opening formed by the Valencian *palmo,* nearly nine inches square; others that it is a volume of water which, introduced into an opening a *palmo*

square, takes a second to run through the space of 4 or 6 *palmos*. But in any case it is agreed that a *fila* of water is sufficient for the irrigation of 400 *hanegadas*, (1,620 *ares*,) or about forty acres. The eight canals of the plains of Valencia are said to actually irrigate 232,922 *hanegadas* of ground, or 23,280 acres. These eight canals run through the whole plain of Valencia. They cross each other, unite, then separate to reunite, and then divide off at a still greater distance. The new branches form in their turn new canals of irrigation, and thus every corner of that vast tract is visited and improved by the waters; everywhere industry has vanquished the obstacles; everywhere she has distributed with complete knowledge thousands of little channels or streams.

The royal canal of Moncada waters the greater part of the left bank of the Guadalaviar. It was in observing this that M. de Passa said he comprehended the beautiful system of irrigation which for ages had been an inexhaustible source of supply in the arid land consumed by the heat of the sun; and that the regulation of the waters, the simplicity of the means, and the economy established, commanded his highest admiration. Its origin is of ancient date. The lands irrigated by it are estimated at about 1,552 *hectares* (about 3,600 acres.) The tax for water is 2 francs 63 centimes (about 50 cents) per *jovada*, (about an acre.)

M. de Passa devotes nearly 80 pages to the various codes or regulations, prepared at different periods, for the management of the waters of this canal, defining or restricting the rights of those using it, with provisions and penalties for sustaining them. Taking in the two regions watered by it, the whole quantity of land thus benefitted is said to be 3,000 hectares, (or 7,500 acres.) It rarely suffers from drought.

The canal of Quart irrigates an extensive tract of country on the right bank of the Guadalaviar. The use of the waters is guarded by well-defined regulations. It is an invariable rule that water is never to be carried backward; without exception, it runs through all the parts of the vast extent, penetrates the most difficult places, crosses other canals by means of bridges and aqueducts, and distributes supplies as it goes. Whether, in receiving the upper streams, it increases its volume, to serve for the irrigation of a new tract, or, having reached the end of its course, it insensibly loses itself and disappears in the midst of the plain, it is directed with the greatest economy and regard to utility.

There are numerous and minute rules for protecting individual and public rights, of which M. De Passa says that, though some may appear superfluous, others defective, and others too severe, yet, when their cause and necessity are investigated, and we observe how much they are respected by the people, we learn that success in agriculture depends on a great number of circumstances which we cannot always divine. He gives great praise to the Moors for their works, such as aqueducts and canals; and, speaking of an aqueduct on the territory of Quart, he says: "On seeing it one may have some idea of the constancy of that agricultural people, whom no obstacle could repel when the question was as to the improving the soil and increasing the riches of the state." He says of the Canal Royal of Alcira that it is one of the most beautiful conduits which the hand of man has prepared for the irrigation of lands. It partially absorbs the waters of the Xucar, and, fertilizing as it proceeds, traverses the territory between Albufera (the beautiful Huerta of Valencia, from which it is separated by the rushing stream of Catarrocha) and the vast curtain of the mountains of Carlet and the plateau of Quart; and, lastly, pursues the course of the Xucar from the rock of Cullera to the narrow valley of Antella. The works are very massive, sometimes thirty-four metres (about as many yards) thick. It is difficult to measure the volume of water which enters this canal at ordinary times. It runs with so great rapidity, and by such a strong fall, that we cannot exactly calculate it. At the entrance of the first funnel, *(entonnoir,)* and in front of the first sluice, *(écluse,)* the water occupies the space of eighty Valencian *palmos*, (eighteen metres, or about twenty yards.) by twelve *palmos* (2.7 metres, about three yards) high. At the end of the same funnel it is forty *palmos* (nine metres, or about ten yards) by twenty, (four and a half metres, or five yards;) and, lastly, at the outlet of the sluices and the entrance of the canal, sixty *palmos*, (thirteen and a half metres, or about fourteen yards;) so that the vertical section of the canal, in the portion occupied by the water at ordinary times, presents, up the river Cuselta, a surface of eight hundred square *palmos*, (one hundred and eighty square metres, or about two hundred yards;) and down the river, of seven hundred and sixty-eight *palmos* (almost thirty-nine metres, or above forty yards, square.) When what has been said of the force of the current is recalled, the immense quantity of water which thus every day enters the Canal Royal may be appreciated. It traverses a wide extent of country, dispensing its fertilizing riches through numerous secondary canals, among which the united canal of Algemesi and Alcira is the most considerable. M. De Passa gives a full abstract of the regulations respecting it, as well as the history of the progress of the legislation, and a variety of other details as to the taxes and expenses incurred, all indicating careful supervision and practical wisdom. Before serving himself with the water every one must have a permit, based on the facts that his land is susceptible of irrigation, and permission to him does not interfere with the rights of others.

In case of great drought the supply of water is to be furnished more sparingly, with the aim to save the crops last irrigated, without exposing those previous in course. An equable distribution is thus made the object of special regard. Fines and penalties are imposed for breaches of the rules, and every effort seems to be resorted to for securing the full benefit of these public works in enriching the fields. Proper tribunals are erected to adjudicate causes according to the code provided. The distribution of the water, it is said, is so well arranged that it comes constantly to every point, even in times of the greatest drought. The existence and welfare of thousands of families depend on this provision. Every fraud committed, all prevention of the right use of the waters, may inflict irreparable injury on many; and hence the scrupulous attention to see that all is properly carried out according to its design.

In case extensive irrigation shall become a feature in our country, and the requisite protection of laws and detailed provisions for carrying on a great public or corporate system of such improvements shall be needed in any of our States, these volumes of M. De Passa will furnish much valuable as well as interesting information on the subject; but it does not consist with the present object or limits assigned to make further extracts. Enough has been given to show that the plans of irrigation, handed down from the early times of the Moors, have exercised an important influence in Spain, and that many tracts otherwise utterly barren have been rendered fruitful by the proper husbandry of these natural resources, so often entirely neglected.

It might naturally be supposed that in higher Northern latitudes, where the intervals between the rains are not so long, and the exposure to drought is not so great as in Southern climes, irrigation would be less likely to become a subject of attention or study. It has not been the case, however. The practice was introduced into Britain by the Romans; and in modern times it has been regarded as an important auxiliary in English agriculture. Attempts were made there on a comparatively small scale in the sixteenth century, but it can hardly be said to have become fairly established in England till the beginning of the present century. Since then it has been conducted extensively in the counties of Wiltshire, Devon, Somerset, and Gloucestershire, and also in parts of Scotland. From the parliamentary returns of 1854 the extent of land under the title of irrigated meadows amounted to 1,292,329 acres, or nearly one-half of the land in clover and artificial grass. The proportion of land under corn and cultivated grass was as three to one of the other description, a much smaller proportion than that of France, which was as nine to one.

The most celebrated water meadows in England, at an early date in modern times, were those in Wiltshire, in the Wesley Bourn, between 1700 and 1705. Others, about the same date, were formed in Hampshire and Berkshire; but they are said to have been far inferior to the former. Toward the close of the 18th century attention seems to have been turned to the subject by various publications, among which those of G. Boswell, in 1780, and the Rev. T. Wright, from 1789 to 1810, are mentioned as exerting the greatest influence. In the Prize Essays and Transactions of the Highland Society of Scotland we have an account of some successful experiments, as well as general observations on the practice and principles of irrigation, embraced in the report of a survey made in the year 1804 of watered meadows, situated on or near the rivers Esk, Ewes, Teviot, Etterick, and Yarrow, belonging to the estate of the Duke of Buccleugh, and containing 362 acres. The object was here, as in English irrigation generally, to raise larger crops of grass, and the results were most satisfactory. The progress of this branch of husbandry in England would, no doubt, have been more rapid and extensive but for the diversion of the proprietors' enterprise to the raising of green or root crops, as clover, rye-grass, mangel wurzel, turnips, &c., in yet larger quantities for their cattle and sheep. The desire of heavy grass crops was thus diminished, and a greater breadth of area was hence given to cultivated land. More recently a new interest has been excited in irrigation, especially in connexion with draining, with which it is most usually joined in England and Scotland. The best agricultural writers give it a place in their works. Questions relating to the theory and practice, and facts relating to the profits to be hoped for, are discussed in the ablest journals devoted to land husbandry. Analyses of waters employed for the purpose have been made, particularly in cases of their successful application, with a view to ascertain the elements so contributed to the nurture and growth of plants. In the course of these investigations much valuable information has been diffused in relation to the chemical properties of river water and the effects it produces in irrigation. The water of the Thames, as analyzed by Dr. Bostock, was found to contain, in 10,000 parts, after most of its mechanically suspended matter had subsided, about $1\frac{3}{4}$ parts of foreign substances, viz:

Organic matter	0.07 parts.
Carbonate of lime	1.53 "
Sulphate of lime	0.15 "
Muriate of soda	0.02 "

In an equal quantity of the waters of the Clyde Dr. Thompson found $1\frac{1}{6}$ parts of solid substances, viz:

Common salt	0.369 parts.
Muriate of magnesia	0.305 "
Sulphate of soda	0.114 "
Carbonate of lime	0.394 "
Silica	0.118 "

The waters of the Itchen, a stream in Hampshire celebrated for irrigation, contained, in 10,000 parts, about $2\frac{1}{2}$ parts of solid matter, viz:

Organic matter	0.02 parts.
Carbonate of lime	1.89 "
Sulphate of lime	0.72 "
Muriate of soda	0.01 "

It is evident that all water employed in irrigation must contain ingredients which furnish nutriment to the plants or grasses. Mr. Cuthbert Johnson, speaking in this connexion, (see Quarterly Journal of Agriculture, vol. X,) says: "There is no agricultural question, therefore, more important, in a national point of view, than that of the improvement of the soil by irrigation, for all the rich organic and other matters diffused through the rivers are saved to agriculture, which would otherwise be carried into the sea. Pure water, as obtained by distillation, it has been clearly shown by the experiments of Dr. Thomson, M. Saussure, and Hassenfratz, is utterly incapable of supporting vegetation. But impure water, from a sewer or dunghill, will do so. Mr. Lampadius found that, though plants placed in a pure earth, as silica or alumina, and watered by pure water, would not grow; yet, when watered with a liquid drainage from a dunghill they grew luxuriantly. The quantity of solid or earthy matters absorbed by plants, it has been proved, is in exact proportion to the impurity of the water with which they are nourished. Equal quantities of beans fed by distilled water yielded, in solid matters or ashes, 3.9 parts; those fed by rain water, 7.5 parts; those grown in garden mould, 12 parts. These facts, and similar ones, are deemed conclusive as showing that the main advantages of irrigation are derived from the foreign substances with which the water is charged. The water which supports vegetation either, like rain, possesses an appreciable quantity of ammonia, or, like the water of clear springs from calcareous strata, a large proportion of carbonic acid; or, like sea water, is strongly impregnated with nutritive salts; or, as in the case of brooks and rivers, is more or less charged with organic matters and nutritive mineral substances."

"The artificial supply of moisture to the cultivated plants of hot countries is the supply, not merely of pure water, but also of the alimentary substances contained in the surface waters of the earth, as an equivalent for the ammonia contained in the rains. A chief function of moisture in the soil, in all or any of the great variety of circumstances in which it contributes to vegetation, is so to hold the nutriment furnished to the plants in a state of solution, that they may, by their absorbent vessels, take it up into their system. If there be a deficiency, therefore, of carbonic acid, or muriate of soda, or sulphate of soda, or chloride of sodium, or organic matter in solution, or a lack of any principle of food in the water used for irrigation, then it must so far fail of its object. But if the plants have a strong capacity for any particular article of their food, and the water of irrigation supply it largely, and one portion of the water so brought in contact with the plant has this element abstracted from it, and the remainder is carried off by the flow, so that another portion may successively take its place, and fresh food be thus continually brought, and the remaining innutritive parts carried off, then it cannot be doubted that the true end of irrigation is reached, and that the process will prove stimulating and nourishing. In these views many writers concur."

Sir Humphrey Davy's theory of irrigation is, that "water is absolutely necessary to vegetation; and when land has been covered with water in the winter, or the beginning of spring, the moisture which has penetrated deep into the soil becomes a sort of nourishment to the roots of plants in the summer, and prevents those bad effects which often happen in lands in their natural state, from a long continuance of dry weather. When the water used in irrigation has flowed over a calcareous country, it is generally found impregnated with carbonate of lime, and in this state it tends in many instances to ameliorate the soil. Common river water, also, generally contains a certain portion of organizable matter, which is much greater after rains than at other times, and which exists in the largest quantity when the stream rises in a cultivated country. Even in cases where the water used in flooding is pure and free from animal and vegetable substances, it acts by causing a more equable diffusion of nutritive matter existing in the land; and, in very cold seasons, it preserves the tender roots and leaves of the grass from being injured by the frost. The reason is, because

the specific gravity of the water is greater when the temperature is at 42° than at the freezing point, 32°; and at this temperature vegetation is not injured." He also states that water which breeds the best fish is best for watering meadows; but any kind of water will do, except that containing iron, which, though it is fertilizing on a calcareous soil, is injurious on soils which do not effervesce with acids. Calcareous water is good for silicious soils. Sir Humphrey Davy's theory has been called in question by more recent writers, who have claimed that, in the present advanced state of chemistry, he would himself have modified its features. Others, however, seem still to rely upon it as furnishing in the main a correct explanation.

Other ends and uses of irrigation have been suggested. It is said to cool the land in summer and warm it in winter. It is said, also, that irrigation acts by washing off the excrementitious matters which injure the growth of plants. Protecting grasses from frost, and maintaining plants in an equable temperature, the mechanical action of a current of water over the irrigated surface, it is held, keeps the roots and stems clear of obstruction, and promotes an equable circulation of water and oxygen around them, as well as an equable distribution of all the soluble materials of food.

In a paper by Professor Rennie, of London, published in volume V of the Quarterly Journal of Agriculture, he controverts the earlier views as to the operation of irrigation on vegetation. Alluding to the declaration of Arthur Young, respecting the effect of muddy floods in warping on the Humber, as spoiling the process, he infers that the increase of fertility produced is owing to the washing out of excrementitious matters previously in the soil, a similar effect being thus caused to that of decomposition by means of the sun's light and evaporation through heat and the passing air in the process of fallowing, and by fire in paring and burning. Irrigation, too, loosens the surface, and carries into it a fresh supply of air. This is shown by the following example: "Throw a lump of tough clay into water, and let the water be a slow running stream, like that of an irrigating current. In a short time the toughness of the clay will in part disappear to some depth upon the surface of the lump, which will be rendered soft and much less tough and tenacious than before it was thrown into the water. Continuing it in the slow current of water it melts down, and, besides water, it will be found to contain a great proportion of common air. In this pulpy state of the lump of clay, turn off the water and leave it to dry; it will be as tough as before, but more loose and pulverized. It must be kneaded, so as to expel the air, before it becomes of its original toughness." Such, Professor Rennie thinks, is one of the most important secondary effects of irrigation; and, if so, it must be beneficial to grass, even if it reaches no deeper than a quarter of an inch.

Reverting to the previous theories, he takes up especially those of Dr. Darwin, mentioned in his Phytologia. Dr. Darwin attributes the effect to depositions of calcareous earth and the solution of nitrogen; also, to defending the lands from frost by flowing water, or by ice when frozen. So, Sir Humphrey Davy maintained that, as water is of greater weight at 42° Fahrenheit than at 32°, the freezing point, in an irrigated meadow the water in contact with the grass underneath was rarely below 40°. But this last statement is controverted by the fact that practical irrigators uniformly advise that the waters should not be let on during frost. Professor Rennie adverts to the conclusion of a previous writer in the same journal, in substance that the main effect of irrigation is produced by some mechanical or chemical action of the water, in a manner unknown to us, on the plants or the soil. This chemical or mechanical principle, regarded as unknown, he believes to be elucidated in some measure by the views he has propounded.

In a later paper of the same agricultural journal, (vol. X,) Mr. Cuthbert Johnson, to whose article reference has been made, says that "if river water is hard, or contains gypsum, (sulphate of lime,) which it certainly does, it must, under ordinary circumstances, on this account alone, be highly fertilizing to meadows, since all grasses contain this salt in very sensible proportions; for, calculating that one part of sulphate of lime is contained in every two thousand parts of river water, and that every square yard of dry meadow soil absorbs only eight gallons of water, (and this is a very moderate allowance, for many soils will absorb three or four times that quantity,) then it will be found that, by every flooding, more than one hundred weight and a half of gypsum per acre is diffused through the soil in water, a quantity equal to that generally adopted by those who spread gypsum on their clover crops, lucerne and sainfoin, as a manure, either in the state of powder or as it exists in ashes." On a similar calculation applied to the organic substances in flood waters, allowing only 20 parts of animal and vegetable matter in 1,000 parts of river water, it will be found that "every soaking with such water will add to the meadow nearly two tons per acre of animal and vegetable matters," which, in five floodings a year, "is equal to a yearly application of ten tons of organic matter." In respect to the great benefit of winter flooding for meadows, the authority of Mr. Simmons is cited, who maintains that this "is derived, in the first place, from the deposits made by the muddy waters on the grass; and, secondly, from the winter covering with water preventing the ill effects to the grass of the sudden transitions

in the temperature of the atmosphere." Mr. Simmons states that "if water has once been used for irrigation, then its fertilizing properties are so materially reduced that it is of little value for again passing over the meadows." The experience of other irrigators is said to tend to the same conclusion. This last fact seems at variance with what is recommended by yet others, and their statement that the water which drains off, by carrying with it a variety of fertilizing matters, is thereby rendered richer for the lower portion of an irrigated farm. The apparent contradiction is probably to be reconciled by the difference of the circumstances and the character of the water used. Mr. Johnson adds: "It is evident, therefore, that the chemical properties of water have a much greater influence in irrigation than is commonly believed." Hence, the quality of the water used in irrigation is an object of first importance, to which the attention of the farmer should be directed. Lord Bacon's definition, in his Natural History of the Advantages of Meadow Watering, may therefore be considered as one of the best ever given, viz: "That it acts not only by supplying useful moisture to the grass, but likewise by carrying nourishment dissolved in water." Mr. Stephens, whose "Practical Irrigation" is probably superior to any other similar volume on this subject, says: "The agency of water in the process of vegetation has not till of late been distinctly perceived. Dr. Hales has shown that, in the summer months, a sunflower weighing three pounds avoirdupois, and regularly watered every day, passed through it, or perspired 22 ounces each day; that is, half its weight. Dr. Woodward found that, in the space of 77 days, a plant of common spearmint increased 17 grains in weight, and yet had no other food than pure rain water; but then he found that it increased more in weight when it lived in spring water, and still more when its food was Thames water."

The objection drawn from the case of the muddy waters of the Humber, to which allusion has already been made, Mr. Johnson regards as sufficiently answered by the fact, that "in those cases the mud did not consist of animal or vegetable matters, but of fine earthy particles, such as clay or chalk, the same as the alluvial soil, actually itself formed of the deposits of the same flood-waters for ages previous, and therefore any further supply was useless, the slime merely covering the grass with mud without adding any fertilizing substance not already in the soil."

Schleiden, who will be recognized as high authority, in his "Physiology of Plants and Animals, and Theory of the Culture of Plants," (Die Physiologie der Pflanzen und Thiere und Theorie der Pflanzencultur,) speaking of fertilizing matters, says: "Of all inorganic manures, spring water is the most important, and in a certain sense comprehending all. According to its origin, it is nothing but a solution of the soluble constituents existing in the soil, and so, in other words, the proper nutrition itself of plants. It is modified when in its course it passes through the various strata of the earth, until it makes its appearance above ground, it receives and deposits many ingredients; on which account every water cannot exert an equally favorable effect; especially in its longer course in the air it loses a great portion of the insoluble calcareous salts, and so rarely answers for plants that require much lime, such as ranunculus, clover, &c. But, as experience shows, it is in every respect a sufficiently nutritious substance for the grasses. The single fact that, by a suitable watering, the dryest sandy soil in warm regions produces wheat harvests in unbroken succession of the same crops, while, on the other hand, our richest cultivated lands appear poor, is enough to prove the perfect independence of our cereals of humus as a nutritious substance." That the introduction of artificial watering in meadow culture (the so-called irrigation meadows) marks an important advance in our modes of culture, no one who has seriously turned his attention to the matter can question.

Professor Johnson (3d vol. 3d series, Trans. of the Highland Agricultural Society of Scotland, 1847–'8, p. 210) speaks of an experiment in irrigation which was very successful, by water, which, when evaporated, gave only 5.2 grains for the gallon of solid matter. The results were the production, on what was formerly almost worthless land, at an outlay of £30 for five acres, of nearly an average of five and a half tons to an acre, causing a consequent increase in the produce of manure on the farm, as the grass was cut green and soiled; an improvement in the quality of milk and butter; and that hay can be now made for winter food; so that the land, before worth only 5*s.* to 7*s.* 6*d.* per acre, was estimated at a rental of £3 to £4. The analysis of this water gave in—

Alkaline salts (chiefly common salt)	1.14	grains.
Sulphate of lime (gypsum, containing 0.28 grains of water)	1.66	"
Carbonate of lime	0.26	"
Carbonate of magnesia	0.46	"
Organic matter	0.76	"
Silica	0.92	"
	5.20	

He remarks, in respect to this water, that "the result of this analysis is very interesting. It shows that what we are in the habit of considering the purest natural spring waters, containing the smallest proportional quantity of mineral matter, may be used with advantage for the purposes of irrigation;" and says that, so far as his experience goes, any water in which water-cresses spring up may be safely employed for irrigation.

"An analysis of the waters of irrigation is not, of course, necessary. Other tests enable the farmer to determine the fitness of the water at his command for irrigating purposes. The good quality of any water as a water of irrigation is shown by the verdure on the margin of the stream and growth of strong cresses in the stream itself. Though the water is perfectly clear, yet in such cases it will generally prove well adapted for irrigation." There are, however, some soils which, owing to their chemical composition, or to the tenacious retentive quality of their subsoil, form exceptions. Two meadows are instanced in the same farm, both situated on the side of a hill, with a southern aspect, the upper stratum a fine rich loam eight to ten inches deep, on a substratum of strong yellow clay. "So far as the eye can discern, there is no difference between the upper mould or substratum, or the herbage growing on their surface, except that in the lower part of one there are a few rushes, in consequence of some small springs which have their rise near by; but there is not water enough to render the land poachy. At the head of these meadows is a large pond, formed from the collection of several small runs of spring-water, also improved by the wash of a farm-yard. Now this same water, thrown over these meadows, in one case produces the richest herbage in abundance, which is regularly mown for hay; but on the other meadow it is of no benefit. Heavy clayey soils are in general unsuitable for water meadows."

"It is regarded as a settled fact that the grass and hay of water meadows are not so nutritious as of permanent pasture lands. The difference, however, as appears by the experiments of Mr. George Sinclair, is less than has been imagined. He obtained from rye-grass, at the time of flowering, from a water meadow on which sheep had pastured till the end of April, 72 grains of nutritive matter; and from the same weight of grass cut from a rich old pasture devoted to hay about the same time, 92 grains. From rye-grass from a meadow not fed off in the spring he obtained 100 grains; and from the pasture not fed off 120 grains of nutritive matter. Mr. Sinclair likewise found the same result in the case of grasses; where the growth is forced by liquid or solid manures, the nutritive matter exists in lesser quantity. From four ounces of rank, luxuriant rye-grass, growing on a soil to to which a large portion of cow-dung had been applied, he obtained of nutritive matter 72 grains; and from the same quantity of grass grown on the soil adjoining, without manure, 122 grains. A second trial of the same kind of grass gave, on a soil destitute of manure, of nutritive matter 95 grains; while on a highly manured soil there were only 50 grains. These experiments were said to have been fairly made with grasses of the same age and otherwise alike. The facts, therefore, do not apply more to the case of irrigation, as a means of producing grasses, than to other methods of causing fertility. Chevandier and Savetat found that two waters used in irrigating meadows produced very different results in increasing crops. They analyzed them, and the quantity of mineral matters was largest in the water which produced the least grass. They supposed the goodness of the water which was most successful was owing to its larger quantity of organic matter, and especially to the nitrogen which this matter contained. The organic matter was nearer an inorganic condition, and the decomposition took place more rapidly when acted on by the air, and thus the roots absorbed inorganic substances from the water just as leaves do from the atmosphere. The fact that irrigation produces more striking effects on sands than clays seems to show that the good effects of water are not from the absorptive powers of the soil, since the water, instead of being retained in the porous sand, passes immediately through it."

The value of irrigation has been abundantly shown in those parts of Great Britain where the experiments have been the most thorough. Among the instances cited the following are taken as specimens: The first is on the bank of the Esk, near Pencuik. Here there was a copious clear spring that for ages had run down a hollow on the bank of a river; the rill from it was carried along the top of a grassy bank, and allowed to run on one spot and then on another alternately, The water was let on in autumn, and continued through the winter and spring, and the first year the result was a strong crop of grass, which, if made into hay, would have yielded 400 stone per acre, (about 4⅘ tons.) It was cut green for horses in June and July, and a second cutting was taken off in autumn, after the water had been again applied. The meadows of Castle Craig, in the county of Tweedale, 800 feet above the level of the sea, were a complete peat-bog. They were prepared aright for irrigating, at an expense of £6 ($30) per acre. The crop produced yielded 466 stone (5 tons 232 lbs.) to the acre. Another of seven acres, which, in some parts, was moss four to seven feet deep, and a third of a similar kind exhibited nearly the same extent. The latter yielded 476 stone (about 5¼ tons) to the acre. Another, on the estate of Whinn, near Pencuik, is mentioned, where the flow moss was from 12 to 15 feet deep. The first process here, of course, was to reclaim it by draining; then it was laid out in suitable beds; it was

next manured, then planted with potatoes, manured a second year, and planted again with potatoes, in both cases yielding good crops. Having become thus well pulverized, it was levelled, and ploughed up into ridges 25 feet wide for irrigation, dressed with lime and earth, and sown with oats mixed with white clover and timothy grass. The first year the grass was cut the ground had not been watered, but the next year it was thoroughly, and for six years after it increased in productiveness, yielding 300 to 400 stone of hay a year (about $3\frac{3}{5}$ to $4\frac{4}{5}$ tons) to the acre. Other cases equally decisive are mentioned.

In Ireland the first experiment made in irrigation is said to have been by a poor peasant who noticed the effects of water from a hill stream. He allowed it to run over a few acres, and was repaid by rich crops of hay; and a bog was rendered passable for carriages which had formerly been one of the most dangerous of swamps. Vast tracts exist in Great Britain, which, by drainage, followed by irrigation, it is asserted, can be reclaimed and rendered highly productive. A moss east of Glencoe, in Scotland, 50 or 60 miles wide, could be so drained and flooded. Another of 100,000 acres could be made good pasturage. According to the report in the House of Commons of the select committee on the bogs of Ireland, Mr. Nimmo calculates, in reference to a meadow which is now an extensive bog more than 1,000 feet above the level of the sea, and which is overflowed in winter and of great fertility—the water being one cubic foot a second for 100 acres three times in the winter—that by concentrating the rain of 100 acres, and allowing it to flow over only 10 acres of bog, at an average breadth of $1\frac{1}{2}$ miles from the top of the hill to the river, the quantity irrigated would be 41 acres 10 perches in every 300 acres of surface, and the expense only about £1 to £1 5*s.* ($5 to $6 25) per acre. The result would be the covering of the surface of the whole bog with the finest soil at the cost of cutting only 10 inches deep.

Rivers, it has been ascertained, in general carry into the sea $\frac{1}{400}$th part of the earthy matter they contain, and mountain streams much more. Allowing this estimate, water at three cubic inches per second, and one-fourth of an inch wide, will in 400 seconds deposit one-fourth of an inch of soil on 192 feet and three inches, and in one month will cover an acre. If the water of 100 acres of upland flow over 12 acres of bog, it will deposit one inch on the whole surface at the same rate. By this it may be seen that a means is at command, through irrigation, of no slight importance, by which, in connexion with due attention to draining, the most unpromising portions of marshy lands may be made rich and productive in the appropriate crops. Even when applied to land already under cultivation, the result is said to warrant the resort to it. Boussingault asserts that the increased fertility of arable land, from the products of irrigation, is greater than the loss on the land set apart for this purpose.

Four kinds of irrigation are generally mentioned in the treatises on the subject.

The first is called Bed-work. This, though the most costly, is also the most efficient. In this method currents of water are brought to level ground. The second is called Catch-work, and is adapted for level and uneven ground, where they are found on the same extended surface. The third is the application of Subterraneous water to the surface by means of drains in the subsoil. Fourth, Warping, or Earthing, where the water stands over a field till it has deposited its fertilizing parts.

It is desirable, if possible, to avail one's self of a river in the formation of a water meadow, because of the fertilizing matters which it may furnish. As a general fact, rivers which flow through alluvial ground are preferable to those which pass over rocky beds. The requisites in this respect are a full supply of water, and that the water shall be of a higher level than the surface to be irrigated. The field, to be formed into a water meadow, must be sufficiently dry, and, if not naturally so, must be drained; otherwise the water will stagnate on the subsoil. No part of a water meadow must be on a dead level; but the water must be kept in constant motion, though it be ever so gently flowing on and off.

In respect to flow-meadows, it is evident that there must be a sward or grass cover before the water is let on to flow over it. In this case irrigation thickens the sward by increasing the number of the leaves, and by inducing their simultaneous production. It also sweetens the turf, because there is an equal and thick growth of leaves at the bottom.

In every case of irrigation of water meadows, the first point is to decide on its practicability. For this purpose it is important to understand clearly the supply of water needed, and whether it is at one's command. This being determined, the next point is the most feasible mode of execution. Here the question how the water is to be carried off, when it is once brought on, is to be examined. A conductor must be made from the river, or fountain, by ascertaining the proper slope and providing the means for the water to flow into it at a suitable rate, if the surface of the ground is not already sufficiently adapted by nature. The size of the conductor depends on the size of the meadow to be watered. It must be made with the bottom as low as the bottom of the river, if the object is to secure the particles of silt or mud which repose there. The course should be straight, on an inclined plane. In respect to the soil, it is an advantage, and gives greater promise of success, if it is on a warm and absorbent bottom, since the subsoil of a water meadow is of

more importance than the quality or depth of the top soil itself. Not merely is it desirable to be able to avail one's self of a suitable stream in the supply of water at the outset, but it is a chief point also to have such a command of a constant and living stream that the water may be equally on service as the irrigation proceeds. In general the land should be in high ridges, raised with drains between them. These ridges are usually regarded as best when measuring from thirty to forty feet wide and nine or ten rods long. This, however, must depend on the lay of the land, the supply of water, and the nature of the soil, which may render some variations necessary.

In the Bed-work irrigation the main conductor is furnished with a sluice, or gate, by which the water, when a supply is reached, may be shut off; and connected with this conductor, or main, there are smaller conductors, or feeders, for the purpose of distributing the water properly through the soil. These feeders are wider at their inlet from the main, and taper to a point at their lower end. A main drain is also made at the lower end of the field, furnished with a sluice, or gate. The object of this main drain is to conduct the water off from the irrigated tract to the river or stream again; or, if used on another field, to the main conductor on that portion. A set of small drains, narrower at their beginning and widening toward their outlet, enter the main drain at different points. The main drain must be wide enough to carry off the water used without delay, so that there may be no stagnation. It must also have a direction parallel to the main conductor; and, in case the stream turns, then a short outlet, or several outlets, as may be best, must be formed to carry off the water collected in the main drain from the smaller ones. The beds or ridges must be formed at right angles to the main conductor, and with a width as above mentioned; in tenacious soils of about thirty feet, and in porous ones yet larger, forty feet or more. If the beds slope in one direction, then the crowns of the ridges are to be made lengthwise in the middle of each ridge. Should the falls of the beds be lateral, as well as lengthwise, the crowns should be made toward the upper side, according to the lateral slope of the ground. The height of the crowns of the ridges should be about one foot above the adjoining furrows. The beds should be made to slope on an inclined plane from the conductor to the main drain, the crowns of the ridges to be cut down where the distribution feeders, by which the beds are watered, are placed. The depth of the feeders must depend on their width, and their width on their length. A bed which is 200 yards in length should have a feeder of the width of twenty inches at the place where it joins the conductor, and tapering gradually to a foot in width at the extremity. The taper of the feeder retards the motion of the water. This motion decreases by its overflow, while it continues to fill the feeder to the brim. Any accumulation of substances must be carefully and evenly removed from the feeders alongside of the beds. The water being let on from the conductor into the feeders irrigates the soil, and then flows off the small drains which are found in the furrows between the beds. These small drains discharge the water into the main drain. Their depth at the junction is the same as the main drain, lessening, as they run back, to 6 inches in tenacious soils, and even shallower in porous soils. Stops—that is, stones, solid earth, or turf fastened by pins—are placed so as to retard the momentum of the water flow at at regular intervals, or when any unequal flow of the current is observed. These ought to be but few, in a perfectly formed water meadow; and there should be no stops in the main drain. Some persons use notches in the side of the feeders; but they are more objectionble than stops. To regulate the distribution of the water there should also be a sluice placed at the head of the conductor, which should be constructed thoroughly, and made to correspond to the elevation or depression of the ground to be watered.

It is as necessary in a well-watered meadow that it should be kept perfectly dry at times as that it should be duly irrigated at others. There should, further, be a small sluice in the side of the conductor opposite the meadow, and at the upper part, to drain the leakage that may occur. The laying out of the beds and the construction of the feeders and drains are the nicer parts in the formation of water meadows; and great care and attention should be given to these points, as on them in no slight degree depends the success of the whole operation.

The ground for a water meadow often requires to be laid over again, to remedy defects that are discovered, and for this purpose it must be ploughed and harrowed. Sometimes, in the preparation, the sward or turf cover must be pared off, and the earth removed from the higher to the lower places, and then the turf replaced carefully. In case there is no such sward, then, after the beds are properly formed, with the conductor, feeders and drains, grass seed must be sown. For this purpose the meadow should be ready by August, and the seeds then sown. Among those which are regarded as best, in the formation of a water meadow, are the perennial rye-grass, sweet-scented vernal grass, crested dogtail, meadow foxtail, rough-stalked meadow and fiorin grasses. Different persons prefer different grasses. Some attention must likewise be paid to the nature of the soil, in the choice, for growth. Fiorin is, perhaps, the prevailing grass, and is sown by being chopped into pieces, like

chaff. Good crops cannot always, of course, be had the first year; but the rye-grass thickens as it flourishes.

Schleiden, in the volume before mentioned, alludes to an objection, which he considers as somewhat well founded, that the hay on irrigated meadows has a tendency gradually to become inferior, and that many nutritious fodder plants may die out by being laid under water; but he says that he believes this difficulty may be easily obviated by borrowing from naturally irrigated meadows—as, he thinks, from the Alps—those plants which succeed so excellently there, which can bear irrigation, and which may be numbered among the most spicy and nutritious meadow plants. He mentions especially two most valuable plants, by the sowing of which the meadows of Germany could be most essentially benefitted, viz: the Phellandrium mutellina and the Alchemilla alpina.

If the supply of the water is short, no more ground should be used than can be suitably irrigated. In cases of any deficiency of water, the adjustment of the sluices should be an object of great care. The first watering is to stimulate the shooting of new roots, which are continually forming, as well as to support the forced growth; but while the grass grows freely a fresh watering is not needed. Keep the meadow as dry as possible after every watering, and be sure to take off the water the moment any scum makes its appearance on it. This especially applies to those meadows which are flooded. In bed-work, as the water is gradually running over the ridges and flowing off, there is, of course, little danger of anything of this description.

The beds being prepared and the seed sown, the irrigation commences. The first watering, as usually recommended, is for the autumn, about the first of October. Everything is to be in complete order, the sluice drawn, and, if the water be abundant, the conductor and feeders can be filled in half an hour. The motion of the water is first into the conductor, then into the feeders nearest to the upper part of the meadow, and afterward into the lower ones in succession. The stops, placed properly, cause the water to overflow the sides of the feeders. This first inundation will exhibit the irregularities, which must be noted and corrected the next summer. There are usually at least three such adjustments before the irrigator can be satisfied that the meadow is even watered to the depth of an inch. This quantity of water must be continued from fifteen to twenty days in succession up to January, according to the weather, whether it is wet or dry, fresh or frosty. At every interval the meadow is to be laid dry for some five or six days, that the grass may have the benefit of air; or, if there should be reason to fear a long and hard frost, the watering must be discontinued, since, in case of freezing and then the thaw of a crust of ice, the roots would be drawn out of the ground, and the soil itself rendered pasty and stringy. Some meadows that require the water in October, November, and December will not bear it a week in February or March, and sometimes scarcely two days in April and May.

Much will depend, in respect to the first crop of hay from irrigation, on the nature of the soil and the condition of the meadow or field when the water is first applied. If the ground is soft and without a previous sward, it should not be watered till the grass seeds have time to form a cover, which may be two or three years after the sowing. If it be already covered with an old turf which can be raised, then, by taking it off neatly with a spade and laying it by carefully, and forming the ground so stripped into beds and replacing the turf, it can be watered. It is well to make a preliminary trial, when finished, before the actual work of irrigation be entered on. In this way it may be seen whether the arrangements are satisfactory and work to advantage. Every season, too, after the water meadows have furnished their crops of hay, and especially where they have been pastured, the conductor, with its sluice, the distribution feeders, and the smaller and larger drains, must be carefully examined, all breaches repaired, and the whole put into complete order before the work of irrigation is begun anew. The expense of the preparation of irrigation by means of bed-work, &c., on land before not worth £2 ($10) per acre is estimated at £9 ($45) per acre; the hay the second year £10 ($50) per acre, and the aftermath £1 ($5) per acre, after which the value of the crop is further increased.

Catch-work irrigation, as before noticed, is adapted to uneven as well as to level ground, and it differs from the bed-work irrigation just mentioned in the particular disposition of the beds or sections of the ground laid out for the purpose of being watered. On level ground the feeders and drains can be made at right angles with the main conductor, and parallel with each other. In catch-work irrigation, however, owing to the unevenness of the ground, they have to be arranged obliquely and irregularly. The best form of this species of watered meadow is probably that which is called "Mr. Bickford's Improved Devonshire System," where it has been tried by a number of eminent agriculturists with great success. A full description of this system, by Mr. Bickford himself, may be found in the Journal of the Royal Agricultural Society of England for 1852, from which a condensed view of its peculiarities is obtained. It presents various advantages over the common system by obviating the necessity for large and frequent level gutters; it also induces and

continues a smooth and uniform surface to the meadow, so that mowing and carting may be carried on without the hindrance of such gutters for irrigation; and when the water is once turned on its spread over the surface is accelerated, while at the same time the soil may be quickly drained when turned off. It is likewise stated that it can be done in half the time, and for less than half the expense.

The first point is to determine where the water enters, or can be made to enter, the meadow. This being ascertained by finding where the best supply can be had at the least expense, then the course where it may be supposed the water will run must in general be decided upon. A level with a plumb line hanging from the point where the two legs meet, which may stretch some five feet from each other, must then be set with one foot on the place where the water will enter, already noted; then place this same foot in the spot where the second foot rested with the plumb line true in the centre marking the level, and so proceed across the surface of the meadow, until a level line has been obtained, indicating by a turn in the sod, or otherwise, every alternate level, by which means the marks will be about every ten feet from each other. As the surface is unequal, the line of level produced will probably show where the water-course, or gutter, is to be made, allowing the water to run in opposite directions, partly to one side and partly to the other of the meadow. After one level line has been formed across the meadow, take another point of departure some ten paces or so lower down on the meadow, and run another similar level line across. This, it is likely, will deviate considerably from the direction of the former line; as the inequalities may be different, and it will correspond to them. The further end of this last level line may therefore be at a much greater distance from the former than at its beginning. In such a case a shorter line may be laid out between these two, beginning at a point where the divergency in the lines indicates not only greater inequality of surface, but also a contrary direction of the water-course. To obtain such knowledge of the way the water will run the plumb line of the level must be allowed to drop a little before the level mark, when the inclination is down the meadow, and a little behind it when it is up the meadow. This will cause the water to run out of the low places, and upon the high places. The level must be followed, and the line marked as mentioned, no matter how crooked it may seem. Care must be taken to go down around every elevation, not to try to cut the line straighter, as this will cause a dry spot below the gutter, or a pond above it. The two lines being completed, return again to the side which was the first starting point, as it will not answer to take a level backward. Take a new starting point, about the same distance from your second, say about ten paces, and proceed as before. The new line will also have its variations, and another supplemental line may be required between it and the next preceding one to render the water-course sufficient for the irrigation. The direction of these longer level lines and the shorter ones between them, as well as that of the run of the water, must, of course, depend on the surface of the meadow. In the case Mr. Bickford gives, he has supposed the meadow to be flat, rising on each side of the middle by two gentle undulations, requiring the lines of the gutter, or the level lines, to curve very considerably. The water, therefore, runs in different directions. These are indicated in the figure which he gives by arrows, and the lines as represented bend down and up as the lay of the land renders it necessary. The lines being marked out by the level in sufficient number, and ploughed, but not "turned out," so as to be perceptible, "it will be easily seen that the curves of the lines form a series of loops, and that the undulations of the meadow are mapped out by the curves going down around the hills and up around the valleys." The water is thus shown to be mainly needed "just above where the curves form their greatest downward bend." The next thing, therefore, is to draw the lines, crossing the level, or gutter lines. These cross lines, on an average, will be at right angles with the others, though they may deviate more or less according to the inequality of the surface. The mode adopted by Mr. Bickford he states to be to walk before some one ploughing, and, dragging his feet, to leave a mark where the plough must follow, the principal care being to go as nearly through the downward loops, or curves, as possible. These cross lines may be taken at considerable distance from each other, and then the intervals filled up so that the space at last, between any two next to each other, may not exceed 15 paces, but be in some instances less; though some persons think that when nearer than 15 paces too much land is cut away.

The gutters now being cut, the turf is to be lifted out and the water brought in. A spirit level is used, and a mark set at every two rods; the gutter is allowed to drop one and a half or two inches, if the nature of the ground will allow it; but at any rate it must not be less than half an inch. This last depth requires a much wider gutter; and it will not run itself dry so well when the water is turned off. The water runs off directly in the two-inch, but hardly at all in half-inch drop gutters. Much depends on where the water is most needed; and the gutter should drop in that direction. If, instead of the further end, it is chiefly wanted at the beginning of the gutter, the drop need not be so much, and the gutter should taper off, almost ending in a point.

The size of the stream must be taken into consideration. If it is of sufficient size to water the whole piece of ground, one gutter large enough for the work should be made, and this without stops, as there is an objection to stops in a gutter. If the stream is small, a leading gutter must be made; and from it must be taken tapering gutters, each of them suited to the stream when it is smallest; and thus, when the stream is increased by rain or otherwise, as many tapering gutters may be used as will disperse the whole stream. The leading gutter, or main conductor, should continually decrease from where the first tapering gutter, or feeder, is taken out of it, and itself end in a similar tapering gutter. Up to the point where the last tapering gutter is taken out of it, Mr. Bickford calls it a carriage gutter, equivalent to a conductor; and the tapering gutters he terms watering gutters: that is, feeders. If the stream is small, a stop in the carriage gutter, immediately in front of the connexion of the first watering gutter, will cause the water to run into that feeder; a stop in front of the point of junction of the next feeder will cause it to run into that feeder; or, if there be no stop, then the water, if sufficient for both, will fill the side feeder, and also run on to the termination, or feeder end, of the main gutter. Should there be water only for one without a stop, it will run on to the end or terminating feeder of the main gutter, which should be made not larger than just to carry the full steam wanted, and should it become too large by frequent cleaning out, cut it anew on one side or the other. In levelling, first use the spirit level, and mark out every two rods; and then, with the plumb line, mark every ten feet, and make the cuts. When practicable, make the hedge trough the carriage gutter, and be careful to see that the water runs in them in such cases, so as to leave no stagnant water in the troughs. In case it is necessary to cross the middle of the meadows, covered gutters or conductors may be used; though more expensive at first, the tiles would not require to be cleaned out every year, as in other cases.

If the stream of water is too scanty for the whole meadow, the water must be confined to the ground marked out by stops in the two perpendicular conductors which run along its sides. The gutters are not to be cut in the same places two years in succession, but on one side, about a foot and a half from the former. The turf of the new gutter must be used to fill up the old one, care being taken not to fill the old ones too greatly. If they are cut on the right hand side one year, and above, then the next year they should be cut on the left hand side, and below; and thus they will, by retaining their position, be as useful at any subsequent time as when they were first made.

An objection against the mode here described is that the only carriage gutter, or main conductor, being on the highest level of the ground watered, generally the best ground, the lower part is irrigated only after the water has lost its best materials, though most needing water. Mr. Bickford, however, asserts that this objection is not sustained by the results; for though, under the old system, provision is made for carrying down the water, yet it is often never so used. There are so many stops to be regulated as to prevent the proper operation of the water and render the machinery complicated and cumbrous, while, as he claims, his system is far more simple, and hence more efficient.

As to the manner in which the water is carried with its suspended matter to the other end of the meadow, Mr. Bickford observes that "the ground is covered with a sort of network of little gutters, from the 'leading-in' gutter at the head to the extreme end of the piece of ground, lying downward from that leading-in gutter—one set of gutters being in a manner parallel to each other, intersected by gutters at right angles to them, and also parallel to each other." It is not strictly true that they are exactly parallel, because the surface is not level, and there must be deviations to meet the undulations; but, on the whole, these deviations compensate each other. Instead, therefore, of carrying the water down by one large gutter, and then dispersing it by another large level gutter, there are twenty or so little feeding gutters every ten or fifteen paces; and, being so small, they do not fret away; and as they are newly cut every year they do not increase in size.

The sections of the meadow for watering on Mr. Bickford's plan are never lateral, or cross ones, but they run up and down the same way the water runs, and the water is not impaired in its qualities by running down the gutters having this direction. This is evident from the fact that as water is good only as it is free from mineral composition, the last part of the irrigation is as good as the first; and as to what it holds in solution, the insoluble matter is of course deposited, and, so long as the water is kept in motion, the matter in solution is carried along with it, the grass or plant which takes up this matter taking up the water at the same time. As the water loses its quality, it loses in quantity, part of it being absorbed by the herbage and part by evaporation; and the remainder holds the same quality as at first. This, at least, Mr. Bickford claims, is so far the truth that it may be laid down as such for all practical purposes now under consideration. Regard must be had to the difference in soil. The water will act best on the best land, and therefore we cannot expect as much good effect on the lower end of a meadow, where the soil is inferior in quality, as on the upper end, where it is superior; for this is not according to sound reason. The little gutters, however, the stops being removed from the perpendicular gutters, and

the level gutters being properly furnished with stops, so as to confine the water to the perpendiculars, will carry down as much water as ought to be carried down. The level gutter of a lower section, if a lateral section is to be watered, instead of being fed by a large stream at the end, is supplied at every 10 or 15 paces by one of these little gutters, and this gives a uniform supply the whole length of the level gutter. If there were more it would do harm, the object being to irrigate the surface, not to wash it. This is not the method, indeed, which Mr. Bickford advises; he only thus shows it to be practicable. He advises that the sections rather begin at the head, that thus a surplus may run down into the little gutters, sufficient for the land that lies below.

In shutting off the water from the "leading-in" gutter the little stops may be kept as they are, the same perpendicular gutters which conduct the water on serving as well to carry it off, thus leaving the meadow surface dry and solid.

These small gutters, or feeders, distribute the water evenly over the surface of the land, as they can be adapted to all its inequalities, an advantage they possess over large gutters or conductors; and, as the perpendicular gutters act as drainers, the water does not gather in little ponds. The water is never over shoe on the meadow in any part of it. The gutters, being so small, are not dangerous to sheep or lambs, do not hinder mowing, and offer no serious obstacle in raking and carting, even by the horse-rake, and do not disfigure the appearance of the meadow. Mr. Bickford claims that his plan has a decided superiority over the old plan for watering the ground in summer, since it requires less water. He does not approve of the grass of summer-irrigated meadows for sheep, as he says it certainly rots their livers; and such seems to be the decision of others, if we may judge from some statements in the agricultural journals. The grass, in such cases, is said to be similar to that which grows from a plentiful rain after a long drought; and this is equally fatal to sheep in producing rot as that of summer-watering in a hot dry season.

Should the stream be small Mr. Bickford advises making a pond capable of holding water enough to run a good stream for four hours or more. A small stream, so collected, it is said will damp a meadow of thirty acres or more.

The comparatively cheap system above described is urged as superior to the old bed-work plan, as such a catch-work meadow can be formed at the cost of £4 ($20) per acre, while on the other system it would cost five to ten times as much, and it has even been applied by Lord Poltimore on a meadow where the fall is not more than 1 in 528, and on levels almost as flat as the banks of the Thames.

The third method of irrigation mentioned is that of *subterraneous* or underground irrigation. Here the supply of water is derived from below the surface of the ground. It answers only for such meadows as are perfectly level and so far raised above the stream supplying the water as to allow complete drainage of the land to be watered. Ditches are, first of all, to be formed at all sides of the field. These serve both as conductors for the irrigation and main drains for carrying off the water when the ground is to be made dry. From the conductors the water flows into the drains, which are at right angles with them, in parallel lines through the field, rises as high in them as the surface of the ground, and then sinks through the soil into the drains, and so off into the stream. The water is to be conveyed from the stream into the conductors through sluices. The submersion of the ground in water must be managed with care and moderation while letting on the water; for should there be a rush or strong current, either at letting the water on or off, the finer portions of the soil would be carried into the river or stream. The only advantage of this species of irrigation is stated to be the moistening of an otherwise parched up soil in dry weather; and for this reason the operation should be conducted in the summer. It is adapted for plough land, as well as pasture or meadow land. As the sediment must reach the surface of the ground through the soil it matters not whether the water be clear or turbid in this kind of irrigation.

A fourth kind of irrigation is called *warping,* and sometimes earthing. This is the term given in cases where the level ground is overflowed with muddy water below the tide mark. It is practiced on the sea shore, and within the estuaries of large rivers flowing through alluvial soils. The object is to secure the deposit of the rich mud for fertilizing the lands so overflowed. Some of the embankments constructed centuries ago in England, and by means of which a large tract of country was laid comparatively dry, have, in later times, had added to them large sluices of stone, with strong doors, to exclude the tide when desired; and from them great drains have been carried miles into the flat country to reach the embanked portions of the land over which the mud is to be spread. These main drains are very costly, openings being made through them and large adjoining districts subjected to the operation of warping. The mud having been deposited, the water returns with the to falling tide to the river. Spring tides are considered the best; and the quantity of mud is so great that from ten to fifteen acres have been known to be covered with a silt, or mud, from one to three feet in thickness, during one spring of ten or twelve tides. The effect here is similar to what is seen on the Ganges and the Nile. Major Rennell states that the

Ganges contains a 200th part of its volume of mud, and thus carries 2,509,056,000 cubic feet of it per hour. In the same manner the Nile contains a hundred and twentieth part of its bulk of mud, or 14,784,000 cubic feet per hour. Other large rivers, like the Missouri and Mississippi, also leave very thick deposits when they overflow their banks, which might, no doubt, be applied in the process of warping. Even the most sterile kind of peat moss is said by this process to have been covered over with a richly fertile soil, and swamps turned into firm and productive fields. The farmer who understands the art of warping can temper his soil to suit himself. At the first entrance of the tide it deposits its heavier particles, such as pure sand; the next deposit is sand mixed with a fine mud; and, lastly, the fine pure mud; thus forming a rich and tenacious soil. The great object, therefore, is to have the second, or mixed deposit, spread abroad as equally as can be over the whole surface; and this is done by keeping the water continually in motion, by which the last deposit is prevented till its proper time, as it can take place only when the water is at rest. Three years may be spent for the purpose; one year warping, one in drying and giving firmness, and one for growing the first crop, generally seed hoed in by hand. To secure the deposit of the silt from the tide, which is so beneficial, the field must be surrounded by a strong embankment, sufficient to retain the water as the tide ebbs. The water is let in by sluices with valves, and the enclosed water, as the tide falls, shuts them. These sluices are placed on the lowest possible level, so that the most turbid water may pass through a channel at the bottom of the embankment. The silt so deposited after the warping is said to be very rich, enough so for any crop. The quantity may be regulated according to the object in view, either as manure or for the creation of a new soil. The main object of warping, however, is the formation of a new soil; and it is surprising how soon this is accomplished. From June to September a soil of three feet may be formed, in circumstances which are favorable, such as a dry summer—even the dryest season and the longest drought. Warping is not good in winter, nor in floods. The water should be completely run off, and the ditches dry, before another tide, as the silt forms in distinct layers, and will not otherwise become incrusted so that the next tide may have its usual effect. The expense of forming canals, embankments, and sluices for warping is estimated at £10 to £20 ($50 to $100) per acre. A sluice six feet in height and eight feet wide will warp from 60 to 80 acres, according to the distance of the field from the river. The embankments may be from three to seven feet in height. The advantages of water meadows and warping, as given by writers on the subject, are very great.

The following statement is from Smith's Essay on Irrigation, as the result on a water meadow belonging to the estate of the Duke of Bedford, in Bedfordshire:

In March, 240 sheep for three weeks, at 6*d.* each per week	£18	0	0
In June, mowed 18 tons hay, at £4 per ton	72	0	0
In August, mowed 13½ tons of hay, at £4 per ton	54	0	0
In September, 80 fat sheep, for three weeks, at 4*d.* each per week	4	0	0
	£148	0	0

It then fed lean bullocks, the feeding not valued, equal to £16 13*s.* 8*d.* per acre.

Another case mentioned by Mr. Pusey was a field of two acres, in Berkshire; good land naturally, but out of condition, so that the hay crop had hardly been worth the cutting; and after irrigation the produce is estimated as—

	Day's keep of sheep.
First, penning sheep put on, but grass too strong to feed, and made into hay, say only	3,000
Second, feeding 400 lambs for eight days, say 240 sheep	1,920
Third, penning 250 sheep for ten days	2,500
Fourth, penning 250 sheep for 14 days	3,500
	10,920

The total amounts to 5 months' keep for 73 sheep on two acres, or 36 sheep to an acre. Mr. Pusey compares the result with the feed in Lincolnshire by a thorough good crop of turnips, said to keep 10 sheep an acre for 5 months; and with good grass land, which fattened 7 sheep to an acre in the five summer months. Admitting the 7 fattened sheep to be equal to 14 of his, kept merely in store order, the account as compared stands thus: 10 sheep on an acre of turnips; 14 on an acre of superior grazing land, unwatered; and 36 on an acre of moderate land, watered. "This investment in irrigation, in one of the dry inland counties of England, is said to have paid him a return of 30 per cent. on the capital expended."

The process of warping is not confined to England. Mr. Cadell, in his "Journey to Carniola," gives an account of a similar method practiced there. He says : "In the Val di Chiana, fields that are too low are raised and fertilized by the process *colmata*, which is done in the following manner : The field is surrounded by an embankment to confine the water ; the dike of the rivulet is broken down so as to admit the muddy waters of the high floods. The Chiana itself is too powerful a body of water for this purpose ; it is only the streams that flow into the Chiana that are used. This water is allowed to deposit its mud upon the field. The water is then let into the river at the lower end of the field by a discharging source called *scola*, and, in French, *canal d'écoulement*. The water-course, which conducts the water from the river, either to a field for irrigation or a mill, is called *gora*. In this manner a field will be raised five and a half, and sometimes seven and a half feet, in ten years. If the dike is broken down to the bottom the field will be raised to the same height in seven years ; but then, in this case, the gravel is also carried in along with the mud. In a field of twenty-five acres, which had been six years under the process of *colmata*, in which the dike was broken down to within three feet of the bottom, the process was seen to be so far advanced that only another year was requisite for its completion. The flood in this instance had been much charged with soil. The water which comes off cultivated land completes the process sooner than that which comes off hill and woodland. Almost the whole of the Val di Chiana has been raised by the process of *colmata*."

By keeping the water on the land 24 hours before it returns to the river, it has been found, in some parts of England, that an increased quantity, as well as a better quality of warp, is obtained. The part of the field most distant from the warping drain receives the best warp ; as the sandy heavy portion of the mud first settles from the waters, the lighter and organic particles, still held in suspension, being carried on to the further portion of the land.

Mr. Herapath, a distinguished chemist, gives, in vol. xi (1850) of the Journal of the Royal Agricultural Society of England, the *rationale* of the process of warping. He first presents some analyses of warping waters, as well as of the warp itself ; then an analysis of the soils after exposure to the air for several weeks at 60° Fahrenheit ; and lastly, an analysis of the crops raised. The details are interesting, but occupy too much space for insertion here. His deductions, however, may be given in substance. By the analysis of the warping water, when entering into, and also when returning from, the main drain, it appears that it undergoes but little change in composition during the process, except in the proportion of the insoluble matters which it held in suspension. Leaving out of consideration what is owing to the saline ingredients of the water absorbed by the soil, the whole increased fertility from warping is produced by the mud, or silt, deposited by the water. The proportion of deposit is considerable ; from the specimens it is seen that, while water in its former state contained 233½ grains per gallon of insoluble matters, which can be separated by a filter, the specimen after warping contained only 24 grains. A gallon of river water, therefore, during the interval of taking the two specimens, deposited nearly half an ounce of warp. Consequently, the land must have received about 8,483 pounds, or rather more than 3¾ tons of anhydrous warp (*i. e.*, destitute of water) per acre for every foot of depth of water that flooded it. Mr. Herapath regards this, however, as a low estimate. One instance is mentioned where a portion of the old channel of the Ouse, deserted by alteration in drainage, containing 800 acres, in less than six years was warped up to the height of 25 feet without any artificial aid.

To the question as to the origin of the warp, Mr. Herapath holds to the opinion that it is not brought in from the sea, because the water at the mouth of the Humber, respecting which the experiment was made, is perfectly clear and limpid ; nor does it originate from land floods, for these always injure the quality of the warp. Hence he concludes that it is produced by the action of the tidal waters upon the strata of soft, shaly clay which form the bottom of the marshes in Lincolnshire, the organic matters being derived from the cultivated land through which the rivers pass. The warp varies according to the season of the year and the state of the weather. In very rainy, rough weather, there is more of a coarse, rocky debris, which is of no use, and so in hot summer months the saline matters are in larger proportion, in consequence of the rapid evaporation of the surface water.

The proportion of the really active fertilizing ingredients, though comparatively small, as seen from the analysis, yet, taking the great amount of warp spread over the land, is very large. Thus, taking eighteen inches as the average depth, the weight of deposit per acre in the specimens Mr. Herapath mentions is 2,829½ tons, which contain of constituents destitute of water 1,485½ tons, as follows :

	Tons.	Cwt.
Soluble salts of river water	47	12½
Organic matters, containing of nitrogen 5½ tons	170	16½
Carbonate of lime, containing of lime 74 tons 2 cwts	103	19
Carbonate of magnesia, containing of magnesia 4 tons 15 cwts	74	11

	Tons.	Cwt.
Alkalies	5	1½
Lime	11	2
Magnesia	48	11
Phosphoric acid	7	17
Silicic acid, sand, oxyd of iron, and other comparatively inert substances,	1,016	10½

A six years' rotation, viz: a crop of beans, two crops of oats and three of wheat, would only remove of—

	40 bushels of beans, weighing 2,000.		128 bushs. of oats, weighing 5,120.		99¾ bushs. of wheat, weighing 5,985.	
	lbs.	*oz.*	*lbs.*	*oz.*	*lbs.*	*oz.*
Sulphuric acid	1	12	1	08	0	03
Phosphoric acid	23	12¾	25	15½	53	05½
Potash	15	15	20	15	30	10¼
Soda	13	10	10	04½	------	------
Chloride of sodium	1	06¼	2	14	0	15
Lime	2	00¼	6	00	1	05
Magnesia	6	04½	13	06	13	03½
Oxyd of iron	0	00½	------	------	------	------
Silicic acid	0	00¼	63	05	0	03
Inorganic constituents	64	13½	143	10	112	13½
Nitrogen	71	03	86	01	126	12

The inorganic constituents, straw, &c., returned to the soil in cultivation, not being here taken into consideration.

This quantity is small, indeed, in comparison to that added to the land as a manure. It is evident, then, how warped land will allow of many successive crops of exhausting cereals without showing exhaustion. Mr. Herapath says that the rotation just given might be repeated thirty times without any manure whatever, before the quantity of nitrogen and phosphoric acid, the two most important constituents of the soil, would be sensibly affected. The value of the warp as a manure, however, does not depend on its chemical constituents, nor on the proportion of nitrogen, phosphoric acid, alkalies, &c., it contains. The mechanical alteration of the soil is of much importance—the alteration effected in the physical properties, as its porosity and capability of absorbing and retaining moisture. Mr. Herapath shows this by a reference to some examples where, by warping, sandy or peaty soils have been greatly benefitted and even converted into rich and arable land. He adverts, also, in this connexion, to the case of the periodic overflowings of the Nile, and states that there is a marked resemblance between the composition of the mud so deposited and the warp alluded to in his own experiments. It is not, however, necessary to quote the analysis. Some statements have already been given as to its continuance, and others in relation to the quantity of its deposit. Professor Ehrenberg, of Berlin, is said to have discovered by the microscope that the mud which the Nile deposits is studded with masses of living animalcules. It is possible that this fact may have some bearing on its extraordinary fertilizing power.

At this point, after the consideration thus given to the views, theoretical and practical, of various writers, as well as the examination in detail of different parts of the subject, it may be useful to sum up the results in a somewhat condensed form. This will be done by incorporating on the basis of Schwerz the main features of the system, and the relations of this branch of husbandry to agricultural improvement and prosperity, and the mode of its practical operation. The *Effects* of irrigation consist: 1. In the supply of directly nutritious substances, among which are water, carbonic acid, ammonia, &c. 2. In the gradual improvement of the soil by the removal of earthy mixtures, accretions, &c., from the roots, which are washed off and away. 3. In preventing, or at least lessening, the freezing of the ground; and also the possibility of maintaining vegetation during the winter. The marcite meadows of Italy afford most striking proofs of this fact. 4. In the destruction of mosses and liverworts, as well as bog plants, if these are mowed off before irrigation, the level of the water standing higher than the stubble left behind, so that it may penetrate into the hollow stalk. 5. In driving off and killing insects and their larvæ, and worms, mice, and moles and other noxious animals living under the ground. 6. In furnishing moisture in times

of drought, and by its action decomposing various matters, and thus supplying nutrition to plants, enriching poor soils, and, by its mechanical action as it flows, keeping the roots and stems clear of obstruction, promoting an equal circulation of water and hydrogen, and so dispensing an equable distribution of all the soluble materials of food. 7. In thickening the sward, where it already exists, by increasing the number and inducing the simultaneous production of leaves, and so sweetening the turf, because it causes an equal and thick growth of leaves at the bottom; encouraging also the shooting of new roots, which continually form in order to supply the forced growth of the plant.

The *Efficacy* of irrigation depends on: 1. The condition of the water. The more gaseous bodies, such as carbonic and nitric acid, ammonia, &c., as liquid manure, and humus portions which it contains, the more efficacious it is. Much nutritious matter, which would be lost otherwise, is thus retained. Water often carries off with it particles of lime or gypsum, &c., dissolved in carbonic acid, in impalpable form. When the carbonic acid is disengaged into the air, these two substances are precipitated on the soil. Hence the efficacy of irrigation is said by Thaer to be greatest nearest where the water rises and where there is most lime. With the increase of the temperature, up to 24° Réaumur, the greater the efficiency of irrigation, while it decreases with the decrease of the temperature. For this reason rain water is more efficacious than river water, and river than spring water. The water flowing through fruitful regions, or coming from thickly populated places, is also the most fertilizing. Bog water, which commonly contains free humates, carbonic oxyd of iron, and other salts, is unfit for vegetation. 2. The time in which the water is exposed to the atmosphere. The longer it is so, the more it sucks in and absorbs the gases mentioned; and in general it is also warmer. 3. The rapidity with which the water flows over the sward. Quickly flowing water in winter freezes but gradually, if at all, and absorbs gaseous bodies better than that which is slow moving or wholly stagnant. 4. The mass of water which flows in a definite time over a green sward. For the greater it is, and the more frequently the water is changed, the more efficacious the irrigation. 5. The circumstance whether the plants are wholly or only partially covered by the water. In the former case no vegetation can take place during the irrigation, as the reciprocal effects of the plants and the air are prevented; hence the plants can be wholly placed under water only when the vegetation is entirely interrupted. On the other hand, the plants are more protected against the frost the greater the stratum of water of irrigation over the grass sward. 6. The temperature and state of moisture of the atmosphere; for the warmer and drier this is the more decisive are the effects of the irrigation. 7. The condition of the soil and subsoil. The drier and more mellow the soil is, the more efficacious is the irrigation. If the soil is light and moist, and the subsoil water-tight, the effect is the least. By the mere loosening of a gravelly subsoil the effect of irrigation is often much increased. The state of the subsoil also, whether porous or heavy, has considerable influence, on account of the expense of preparation. A warm and absorbent bottom is regarded as desirable, as the subsoil is considered of more consequence than the quality and depth of the top soil. Hence it is necessary often to drain the land of all redundant water, both before and after irrigation, and thus form a dry, sound and warm bottom. 8. The time at which the irrigation is undertaken. If the meadows are watered in August, the vegetation may be prolonged for some weeks, as the water prevents the early freezing, and so the early stoppage of vegetation. Besides, the grasses in the autumn stock much stronger than they do in the spring, in which the growth is more directed outward, and therefore the grass sward in the autumn irrigation is much thicker, and the weeds, and especially the mosses, more effectually destroyed. In the spring the vegetation grows much earlier on the irrigated meadows than on those not watered, in case warmed water is employed. If the water is too cold, and the plants begin to start out, then the spring irrigation is injurious. When the water does not freeze in the winter, the irrigation may be undertaken during this season, which causes the vegetation to continue through the whole year; and so the meadows, in particularly favorable circumstances, (in warm climates,) as in Lombardy, may be mowed in March, or the so-called winter (marcite) meadows of Lombardy may be adopted. It must likewise be kept in mind that the warmth necessary for the vegetation of plants must never be abstracted, the water never being allowed to form a cover of ice on the watered surface. Snow water must not be suffered to remain unused, because it greatly promotes vegetation. 9. On the mode of applying the water. The main particulars stated by Schwerz are, that the water be distributed uniformly and in as thin a stratum as may secure the object; that there be a gentle and gradual dispersion of it over the surface, so as to leave not the smallest grass stalk untouched, wholly cut off from the air, and disturbed in its growth; that it be not allowed to become stagnant in any place, but ready passage given, and the surface rendered entirely dry. 10. The surface to be irrigated. This may be either comparatively level, gently descending, or steep, and provision must be made accordingly. The slopes may be in one, two, or more directions; and, of course, in any of these cases the mode of promoting the flow of the water must depend on the ease and

adaptation of the lay of the land, and the character of the stream which is to supply the water.

The *kinds* of irrigation are: 1. Surface irrigation by means of conductors and drains. This is of two sorts: *a*, bed-work; *b*, catch-work. 2. Earthing or warping—*i. e.*, flooding by means of dams and sluices. 3. Subterraneous, or under-surface irrigation. In the first two the water is brought in on the surface from a height above it; in the latter from below, upward through the soil.

1. Surface irrigation. Here it is evident—(1.) That the water should be conducted in upon the highest portions to be watered. An indispensable condition is that there be no preventing water in the subsoil, and no standing water over the surface. (2.) That the ground be adapted, and the surface laid as evenly as possible, or in convex beds. (3.) That there be a main conductor; secondary mains or distribution feeders; a main drain; small drains; stops. (4.) That the water in the distribution feeders must be raised or extended as much as possible, in order to effect its passage through these conductors over the bank, or edge. (5.) That the water be distributed as evenly as possible, and nowhere remain stagnant, because by being so a marsh and bad grass sward are produced. To realize these conditions the ground must be properly levelled and made even, and arrangements prepared so that the water may flow uniformly out of the conductors, and run off rapidly. The turf where it exists must not be removed, unless necessary for levelling, and then it must be replaced; the depressions must be filled up, and whether the earth is to be taken for this purpose from one or both sides must depend on the locality. If the inequalities are of considerable extent the grass sward may be scaled from the higher and lower places, and the earth carried from the elevations into the hollows, and then the sward or turf replaced. The practical constructions required for the uniform distribution of the water, as to extent, size, &c., are to be regulated wholly by the condition of the ground. Two conditions are always found—the level and the inclined. If the ground is wholly level, or so little inclined that the inclination coincides with the slope of the whole region or extent of land, then it is not suited naturally for irrigation; for the water will not flow off at all in the first case; and in the second only so very slowly that the soil in part of it becomes marshy. If the descent or natural fall is very slight, the ground must be ploughed up and prepared. In such a case the fall to be given must be accurately fixed upon, the surface turned and converted into beds, or ridges—say from 24 to 70 feet utmost breadth, and 100 to 120 feet long at the greatest extent. On the ridges of these beds construct trenches, or conductors, or feeders, either with horizontal banks or merely horizontal bottoms, from which the water overflows and irrigates the land. The small feeders may be from 6 to 10 inches broad, 3 to 6 inches deep, and 70 to 100 feet long. If the ground has an inclination of 1 : 50 it can be irrigated. The fall of 4 inches to the rod, and so 1 : 36 is regarded by Kloth and others as the best adapted. Schwerz assumes 45° inclination as a basis of some calculations; and, in this case, having the depth of the conductor needed, he doubles this and adds the breadth of the bottom, which will give the diameter at the top, and of course the inclined sides or walls needed. If a greater slope than 45° is required, take the depth for one side and only half for the other. Thus, the depth two feet, the breadth at bottom one foot, then $2 + 2 + 1 = 5$ feet, the diameter at the top.

Taking a level area, Schwerz mentions the following as an easy mode of determining the requisite fall, where instruments are not used, except for the level. Walk the whole length, from the beginning to the end of the surface, counting the paces or steps, and divide, in case the supply of water is large, by five, or if less, by four, and take for every unit of the quotient one-half an inch for the fall. Thus, if the length is 400 paces, divided by four it gives 100, and so 50 half inches, or 25 inches equal two feet fall. The greater the slope, in general, the narrower and deeper must be the conductor.

Schwerz has given some *Rules* in reference to irrigation, which, as they are clearly marked, may be appropriately introduced in this Summary.

The best time for irrigation, he says, is in autumn, as it can be prolonged one, two, or three weeks, and after drying off may be repeated twice. In reference to spring irrigation, he furnishes the following rules: 1. That it begin when the life of the plant begins to start out, and hence after the cold winds are over. 2. That, if it be not injurious, it is at least useless, to water the land in the sharp weather of March, (*i. e.*, in a cold climate, like Germany.) 3. That a soil well dried up by the March wind the more gratefully receives the water conducted on it, and thus becomes warmer; for the moisture is colder which the soil has at this season of the year, but that which it has to expect from the irrigation is warmer. 4. The second half of April and the first half of May is the best time for spring irrigation. Summer irrigation, it may be observed, is rather a mode of refreshing than of watering the grass. After the hay harvest, the meadows should remain dry for eight or ten days, that the grass stubble may dry up and die. 5. Then the autumn irrigation may commence and be conducted as usual.

The following are the directions by which, according to Schwerz, irrigation is to be con-

ducted. They apply, as it may be seen, to the subject as embracing irrigation at different periods of the year:

Rules for irrigation on the surface.—1. The water must not be changed as long as the heat of the day continues. A rapid transition from heat to a freshening—from warm to cold—injures vegetation. 2. The change of water during the prevalence of cold nights is best about mid-day; in a warmer time, an hour before sunrise, or an hour after sunset. 3. Do not change when there is a heavy dew, as this would hinder the beneficial effect on the places receiving the dew. 4. Let on the water in rainy weather, if there be a beneficial warm rain; it is then that the brooks and springs which serve for watering are laden with manuring substances, which the rain water brings with it. 5. If there is about to be a frost in the night, in April, May, or June, let the water, if possible, be brought on in the evening. 6. If, unexpectedly, there is a night frost, and a bright and sunny day will apparently follow, in the morning, before sunrise, make all haste to bring in the water as quickly as possible. 7. If there is a cold rain, water as quick as you can, in order, by the milder temperature of the irrigating water, to temper or equalize the falling rain. 8. If very dry weather occurs in summer, and little dew falls, and the grass withers and does not grow, let the water on and off, but not longer than from 12 to 24 hours, and best over night. A grass accustomed to the water is more susceptible to drought than any other. 9. If the nights begin to be warm in the first half of May, and a warm rain fall several times, the irrigation must often be broken off; less in a cold rain and rough weather, particularly when some warm days have directly before passed over. 10. An over saturation of moisture produces rot in the roots of the grass. In wet seasons irrigate little; in very wet ones, not at all. 11. After the thaw of the winter frost, and the flood in consequence of it, whether early or late, lay the meadow dry, and leave it in this state till the warm days of April and May. 12. If there is a previous flood in the autumn, and only a little or none at all in the spring, then let there be a strong spring watering, even in March. 13. Forget not that the time of the previous flood is the time of proper irrigation, and that of May and June is merely a refreshing. But where the water brings on manuring particles for the whole year, then irrigation is of advantage for the whole year. 14. The dry soil must be watered longer; the moist shorter; the sandy, gravelly, pebbly, longest of all. The watering must cease on the lowest places first; on the highest, last. 15. In a slight fall the irrigation must be shorter; where there is a deeper one, longer. 16. A meadow facing the north or west needs less, one sloping toward the south or east, more water. 17. The fresh introduced water never produces better effect than when the soil has become dry after previous watering. Nothing produces worse grass than continued watering. 18. As far as possible, avoid all rush and currents of the water. The more quiet and uniform the water flows between the grass the more manuring particles it deposits. 19. On sour, marshy meadows, let in a powerfully streaming water, which will wash out the foul and noxious moisture, destroy the moss, and oppose many hurtful bog plants, and render miry soil more firm.

Warping, or earthing-flood irrigation, is the kind where the water stands for a time on the grass-sward, or surface, and then is drawn off at pleasure, leaving a deposit; thus the land can at pleasure be laid dry. In this case, among the arrangements there must be, 1, a surrounding dam; 2, sluices to let on the water, and others to let it off. Warping is distinguished from the former kinds of irrigation by the fact that, in the former case, the water flows over or through the land, and then off; whereas, in this case, it is continued on for some time. There are also naturally flooded meadows where no dam is used. The water must be brought in at the highest point, and let off at the lowest.

In the preparation of the dam we must be particular—1. That it shall have the requisite stability, and the bottom diameter twice as great as the top, and the inclined sides turfed or swarded. 2. That the top of the dam shall be at least 12 inches above the flooding water, so that the waves may not beat over it when the wind blows. 3. That the water shall be uniformly distributed, as rapidly and as much as possible over the whole soil. This requires the unevennesses to be attended to; and a meadow of great extent and slope should be divided into sections, with their dams, which may be flooded one after another, beginning at the lowest grade. 4. That the water be rapidly drawn off from all portions, so that there may be no marshy spots. Grounds of large extent and slightly inclined, and so not naturally adapted, without ploughing up, must have the feeding sluices of 3 feet to 5 feet apart, 3 inches deep and 8 inches broad, by means of which the water can be let on and uniformly distributed, and also drain sluices provided for letting it immediately off. The thickness of the deposit is to be determined by the richness and rapidity of the water; and this also regulates the time the water should be left on the surface of the ground. The continuance of the flooding is further to be guided by the course of the weather and the state of the soil. If the weather is dry and cold, the soil loose and porous, the water muddy or turbid, and the grass land has been manured in autumn, then the flooding may continue a longer time—often two to four weeks; in contrary cases a short time only—often only six to fourteen

days. In all cases the scum or top is decisive to show that the water must be drawn off, as this is the result of beginning putrefaction ; and likewise as soon as vegetation shall begin on the adjoining grass land the flooding must not be so carried on.

Besides these general principles there are in Schwerz some particular rules as to this mode of irrigation, which may be usefully quoted here:

Rules for warping or earthing.—1. This may be practiced in autumn as well as in winter and early spring ; but not too late, when the grass has shot up. In such a case the water must not be more than two inches above the surface of the soil. 2. Let the water stand until the soil is believed to be wholly penetrated. 3. Watch in warm weather for the scum—the mark of beginning putrefaction—forming on the water, and then directly and as quick as possible, draw it off and leave the meadow dry. The observance of this rule is of the greatest importance. 4. The first warping of autumn, according as the soil or subsoil is more or less loose and thirsty, may be continued two or three weeks. Afterward let there be a quick alternation of letting it on or off till the winter sets in. 5. An indispensable condition before bringing in the new water is that the soil should be dry. But this drying off determines the more rapid or gradual warping again. 6. If the winter should come unexpectedly, and freeze the water, it will not greatly injure the meadow. But it is better to have it lie dry in the winter, because then a fresh warping in the spring can be had so much the earlier. 7. The mode of warping in the spring is much like that of autumn. The first, according to the nature of the soil, may be continued on eight to fourteen days ; but afterward it must be let on prudently ; and every time, after the previous drying off, for a shorter time as the year advances, until at the shooting up of the grass it must be relinquished. Thaer gives the following condensed rule for this kind of watering: The more porous the soil the more frequent and the longer can we continue it ; the less porous the less often and the shorter must it be. In dry weather, more heavy ; in wet weather, more feeble. In the cold let it be longer continued ; in the warm weather let the water off more quickly.

Schwerz thus summarily gives a view of the *advantages* and *disadvantages* of warping compared with running over the surface irrigation by conductors, &c.:

Advantages.—1. The meadow can be protected against the influence of cold and unfavorable weather. 2. The yearly expense and often the first cost of the constructions are less. 3. All insects and animals can be destroyed more effectually. 4. In muddy water all slimy particles, &c., are deposited, enriching the soil.

Disadvantages.—All good plants cannot bear it. 2. The grass growing under the water, or kept too long so, grows soft and is damaged, and, by being uncovered, is more exposed to the weather. 3. If a beautiful warm time occurs, a warm sun or a healthful dew, the grass loses the benefit of it. 4. It cannot be continued till the grass begins to flower, as in the other case. 5. Though the quantity of fodder is great, it is not equally good or nutritious. 6. There must be a strong efflux of water, because the water must run on at once and more rapidly. 7. Many soils become too much softened by the water standing on it. It is not to be denied that, if we can have a choice, we must prefer the other kind, (the surface, by conductors, &c.)

As to the *subterraneous* irrigation, drainage forms an important feature in cases of marshy spots. The water is thus conducted from lower to higher grounds by means of drains with sluices, and by capillary attraction it rises in the porous soil, and permeates and so moistens the roots of the plants. Drains and sluices are parts of the arrangements as well as conductors ; for the water is dammed up below, and then, by sluices and conductors, flows over both sides, and spreads forth mounting upward. The conductors or feeders must have their water higher than the surface of the water when it is let in.

Hlubek furnishes a great variety of formulas to determine the velocity of water, the falls and profiles ; also a table calculated for a mass of water of from one to twenty-five cubic feet, which show the precision with which the subject is examined in Germany.

Among the agriculturists of England, Mr. Mechi has been distinguished for his success in various methods of improving land. He speaks in high commendation of irrigation in general, and seems to have tried numerous experiments with a kind of irrigation not yet particularly adverted to, viz: that of sewage waters, or from tanks of water more or less thickened with manuring substances, and then conducted on the land. Attention has recently been turned to the subject in connexion with the sewage of cities, and many valuable articles are to be found in the agricultural journals ; but as the topic belongs to rather another branch of the means of fertilizing lands, it will be but alluded to. Near Edinburgh liquid manure from sewage has been applied with great effect, and the grass has to be cut once a month from April to November, and is said to be remarkably tender and succulent, producing rich milk when fed out to cows. Some meadows, once arid and worthless, by being so flooded, have risen to an enormous value, and are stated to be annually let by public auction at prices varying from £15 to £32 ($75 to $160) per acre. It is estimated that the quantity of green food cut annually from each acre is from 50 to 80 tons.

Mr. Mechi, speaking of irrigation, says: "By irrigation I am enabled to double, if not

treble, my root and green crops, and thus render them profitable, instead of unprofitable. It is quite clear that if I can double my stock, I also double the quantity of my manure, and thus importantly affect the cereal crops. If I double my root and green crops, I diminish their cost one-half. Every practical farmer knows that the losing part of his farm is the root crop, (where we have hot summers and little rain.) Irrigation changes all this. I am forcibly reminded of the truth of this statement by a five-acre pasture opposite my residence. Vainly did I try by solid manures to render this vile plastic clay into a useful pasture. It was like bird-lime in winter and cast-iron in summer; poor, indigenous, and drab-colored grasses choked and eradicated the finer kinds I had sown, and the animals wandered about hollow and dissatisfied. In the space of eighteen months irrigation has changed all this. New, fine, and fattening grasses have clothed the field with perpetual verdure; it keeps three times as many animals, and the close and shaven pasture indicates their affection for it; but milk and cream alike testify, by their richness, to the fertility of irrigation, whilst the animals are improved in their condition." Professor Way, in his recent valuable analysis of grasses, in the Royal Agricultural Society's Journal, has revealed the astounding truth that irrigated grasses contain twenty-five per cent. more meat-making matter than those not irrigated. "We know that grasses are voracious drinkers; they cannot stand drowning on undrained land in stagnant water, from which their roots soon extract all the oxygen; but see how prim and green they look beside any trickling rivulet." "Change of air and change of water are as necessary to the roots of plants as to living animals. All this is effected by drainage and irrigation. It is no uncommon thing for us to saturate the soil to the depth of five feet in the very strongest clays, making the drains run with the precious fluid, diminished, of course, in strength and value." "Plants search for, take up, and feed on these things. As an instance of it, put a vine within ten feet of a river, and it will send out a root that will reach the water and take it up, thus showing, if it has not reason, it has instinct." Again: "My own experience of irrigation this year has shown me that, in the production of root and green crops, I can, on my miserable soil, surpass all efforts on the very richest valley lands. If it can be done in my case, it can in others, where the land is naturally or artificially drained. The irrigation, irrespective of manure, by the water used in our towns and cities would be most valuable." "Not to irrigate the former (Italian rye-grass pasture) is to have no second crop, and the latter (green crops) become, by irrigation, of rich and fattening quality." "The ordinary pasture, which was once fertile, now grows us abundant hay, and we are enabled to feed it up to the 12th May. The aftermath is also rendered, by irrigation, very productive." "A calm review of my seven years' experience in irrigation enables me to reflect on the suicidal waste of manure occurring in this great food-requiring queendom." Such is the testimony of Mr. Mechi; and his little work, "How to Farm Profitably," contains much more to the same effect, and especially details as to the advantage of employing liquid manure of all kinds in irrigation.

Mr. Mechi employs pipes and pumps for the purpose of his operations; but the application of steam power, it is believed, has not been attempted for the object of raising water into receptacles for irrigation. And yet, when it is conducted on an extensive scale, and water is to be brought from a distance and in large quantities, and raised to considerable heights, it is probable steam-engines may be hereafter used as a most important and effective instrumentality, as in the case of draining. To saturate a square yard of a calcareous, sandy soil with water to the depth of one foot in irrigation, it is said, requires about thirty gallons of water, which is equal to 145,000 gallons per English acre. Now two engines, one of eighty, the other of sixty-horse power, working only ninety-six days of twelve hours each, in drainage raised more than 14,000,000 tons of water several feet. The district drained was over 25,000 acres, and it was previously a complete swamp. A common condensing engine, with one bushel of coal, can raise more than 50,000,000 pounds of water to the height of one foot. From this it would seem that there may be a great saving of labor, and an immense increase of the amount of water secured at a small cost.

A brief outline of the irrigation of the rice grounds of the South may be properly given here, as this is almost the only example of the practice of artificial irrigation known in this country. The description is taken from articles by R. Russell (in the Journal of Agriculture, vol. vii, new series) on the culture of rice. He is speaking of rice plantations above Savannah, on that river:

"Main canals, having sluices on their mouths, are dug from the river to the interior, about twenty feet in width; and, as they sometimes extend across the whole breadth of the swamp, they are more than three miles in length. The rice plantations are subdivided into fields of about twenty acres each. The fields have embankments raised around them, with sluices communicating with the main canal, that they may be laid dry or under water separately, according as it may be required. Numbers of open ditches are also dug over the grounds for the purpose of allowing the water to be more easily put on or drawn off."

"In all cases the water is admitted to the fields as soon as the seed is sown, and when the young shoot appears above ground, the water is drawn off. In the course of a week the

crop usually receives another watering, which lasts from ten to thirty days, according to the progress the vegetation makes. This watering is chiefly useful in killing the land weeds that make their appearance as soon as the ground becomes dry. But, on the other hand, when the field is under water, aquatic weeds, in their turn, grow up rapidly, and to check their growth the field is once more laid dry, and the crop is then twice hand-hoed. By the 1st of July the rice is well advanced, and water is again admitted and allowed to remain on the fields until the crop is ripe. This usually takes place from the 1st to the 10th of September. The water is drawn off the day previous to the commencing of reaping."

"It will be seen that large capitals are necessary in the culture of rice on the tidal swamps. A great expenditure of labor is constantly required to maintain the banks in good order, and to clear out the drain and canals, as well as to keep the sluices and valves in repair. The fact, however, of the rice grounds being higher than any land devoted to any other crop, is quite sufficient to attest the profitableness of rice culture."

Mr. Russell also speaks of the rice grounds on the delta of the Mississippi, where the culture is carried on differently from that followed in the tidal swamps of Carolina. He says: "The Mississippi usually begins to swell in the delta about the end of February, and continues to rise till the 1st of June, from which time it again gradually subsides. It is thus in flood during the hot season. A ditch, having a sluice on its mouth, is dug from the river toward the swamp. The land immediately behind the levee, being the highest, is cropped with Indian corn and potatoes; but, at a little distance from the river, where the land is lower and can be flooded, it is laid out in narrow rice fields, parallel to the river, inclining off from the river's edge. The narrow strips are banked all around, so that they can be laid under water after the rice is sown. The land is ploughed in March, and shortly afterward it is sowed and harrowed. As soon as the young plants appear above ground, the water is admitted for the purpose of keeping the weeds in check. The crops grow rapidly, and the depth of the water is gradually increased, so as to keep the tops of the plants just above it. There is a constant current of water flowing from the river into the fields and over the swamp, so that there is no stagnation, and the fields are not laid dry till the crop is ready to cut. The only labor that is bestowed in the culture of the crop is to pull up by hand the weeds, which are mostly grasses; and this operation is effected by men going to the fields knee-deep in water." "The produce varies from thirty to sixty bushels of rice in the husk." The quality, however, (Mr. Russell says,) is not equal to that of the Carolina, as less skilful management is applied in its culture.

In this connexion it may be interesting to learn the mode in which irrigation is used in the culture of rice in the island of Java. The account is taken from Sir Stamford Raffle's History of the Island of Java. He says: "Water, which is so much wanted, and which is seldom found in abundance in tropical regions, here flows in the greatest plenty. The cultivator, who has prepared his *sáwah* or rice field, within its reach, diverts part of it from its channel, spreads it into numerous canals of irrigation, and thus procures from it, under a scorching sun, the verdure of the rainy season, and in due time a plentiful harvest. Nothing can be conceived more beautiful to the eye, nor more gratifying to the imagination, than the prospect of the rich variety of hill and dale, of rich plantations and fruit trees, or forests, of natural streams and artificial currents, which presents itself to the eye in several of the eastern and middle provinces at some distance from the coast."

Again, he speaks of the office of the priest of the village to keep a reckoning of the minor seasons for the sake of husbandry. He says that the first, commencing after the rice harvest, which falls in August or September, lasts forty-one days; the second, twenty-five days; the third, twenty-four days; the fourth, twenty-four days; and then, he adds: "During the fifth, (in January,) which lasts twenty-six days, the implements of husbandry are prepared and the watercourses are examined and renewed. This is the commencement of the wet cultivation. In the sixth season the ploughing of the *sáwahs* and sowing of the *bíbit* for the great rice crop takes place. This season lasts forty-one days. In the seventh *pari* is transplanted into fields, and the courses of the water properly directed. In the eighth, which lasts twenty-six days, the plants shoot above the water and begin to blossom. In the ninth season, which consists of twenty-five days, the ears of grain form. In the tenth, also consisting of twenty-one days, they ripen and turn yellow. The eleventh, which lasts twenty-six days, is the period for reaping; and in the twelfth, which consists of forty-one days, the harvest is completed, the produce gathered in, and that dry, clear weather prevails, in which the days are the hottest and the nights are the coldest in the year." "The periods above described chiefly refer to the progress of the principal rice crop, as influenced by annual rains; but there are many lands rendered quite independent of these rains by the vicinity of streams, which afford a plentiful supply of water at all times of the year." "Lands in Java are classed under two general divisions: lands which are capable of being inundated directly from streams and rivers, and lands which are not. The former are termed *sáwah*, the latter *tégal* or *gága*. It is on the *sáwahs* that the great rice cultivation is carried on; and these admit of a subdivision according to the manner in which the land is

irrigated. Those which can be irrigated at pleasure from adjacent springs or rivers are considered as the proper *sáwah;* those which depend on the periodic rains for the whole or principal part of the water by which they are fertilized, are called *sáwah tádahan.* The former are by far the most valuable; and lands of this description admit of two heavy crops annually, without regard to any particular time of the year. The fields seldom exceed forty to sixty feet in breadth, and the water is retained in them by means of a small embankment of about a foot in height. On the slopes of the mountains, where this mode of cultivation is chiefly found, these fields are gradually carried above each other in so many terraces, for the purpose of irrigation, the water admitted in the upper terraces inundating each of them in its descent." "In the *sáwahs* of Java the fields are previously ploughed, inundated, and labored by animals and hoeing, until the mould is converted into a semi-fluid mire; they are then considered fit to receive the young plants. No manure is ever used. One of the chief characteristics of the soil in Java is an exemption from the necessity of manure; on the *sáwah* lands the annual inundation of the land is sufficient to renovate its vigor, and to permit constant cropping for a succession of years, without any observable impoverishment. In the cultivation of the *sáwahs* the plants are uniformly transplanted, or removed from their first situation.

"In raising rice in the *sáwahs* inundation is indispensable till it is nearly ripe. The seed is first sown on a bed prepared for the purpose, about one month before the season for transplanting it, and the plant is during that time termed *bíbít.* Two methods are in use. According to the first, called *úrit,* the ears of *pári* are carefully disposed on the soft mud of the seed bed; in the second, called *ngéber,* the seeds are thrown after the manner of broadcast in Europe. In by far the greatest portions of the island, the ground is prepared, the seed sown, and the plant removed, during the course of the rainy season, or between the months of November and March. In situations where a constant supply of water can be obtained from springs, rivulets, or rivers, two crops are produced in the course of twelve or fourteen months; but the advantage of double cropping, which exhausts the soil without allowing it time to recover, has been considered as very questionable. If, in some situations commanding a supply of water, the earth is allowed to rest after the preceding harvest, during the latter end of the rainy season, and the transplantation made in the months of June and July, it generally yields more profitable crops than the common method of working the *sáwah.* This, which is termed *gádu,* has been recommended by the experience of European planters. Irrigation is exclusively effected by conducting the water of rivers and rivulets from the more or less elevated spots in the vicinity, and in this respect differs materially in its process from that of Bengal; for, although considerable labor and ingenuity are exercised in detaining, regulating, and distributing the supply, by means of dams called *bandán gans,* no machinery whatever is employed in raising water for agricultural purposes on any part of the island. The rice grown on *sáwahs* is of two kinds, *pári génja* and *pári dálam.* In the former, the harvest takes place four months after the transplantation; in the latter, six months. *Pári génja,* having the advantage of a quicker growth, is therefore often planted when the rainy season is far advanced. *Pári dálam* is more prolific, and yields a grain of superior quality, comprising those varieties in which the ears are longer and more compound. The varieties of each kind are distinct and permanent."

Irrigation has been practiced to some extent in California. Allusions to it are found in some of the Reports of Explorations made to the War Department, from which it appears that in the Los Angeles valley recourse is had to "irrigation by *sequias* (*i. e.*, open drains) in the upper valleys, at San Fernando and Kikal Mungo." "Without this system the plains of Los Angeles could not produce the excessive crops of grape vines which they do. In the spring and early summer there is abundant water derived from the melting of snows on the Kikal Mungo and the San Bernardino ranges, which are occasionally retained on their summits to the middle of summer, and supply the numerous *arroyos* and creeks that find their way into the San Gabriel or Santa Anna rivers." "Most of the fine graperies near the pueblo Los Angeles extend along the river side. One proprietor, Don Luis Vigné, had forty-two acres under his vineyard, the largest in the country. The vines are planted in rows of hills, the plants being about six feet apart each way. They are watered by *sequias* or open drains from the river, which roll in a channel down one side of an allotment, with side sluices for allowing small streams to flow in between the rows and irrigate the ground. The water is allowed to lie on the surface from four to six days, and is then shut off; and this process of irrigation is repeated several times during the early growth of the fruit."

Artesian wells are represented to have been used in some parts of California for the purpose of supplying water for irrigation; but no account of their cost and efficiency has been given in the authentic reports.

There is hardly any people in Asia or in Africa who have not more or less resorted to the practice as a means of giving moisture to the various crops grown on their fields. Two or three instances may be cited as contained in the narratives of travellers.

Richardson (vol. i, p. 198–200) says: "Irrigation is the grand means of agricultural

production in Sahara. Without irrigation the oases would be mere halting-places for caravans, and would afford but a scanty supply for human existence." "In Ghat, Ghadames, and other oases of Sahara, as well as in the greater part of the Tripoline coast, this system of irrigation [*i. e.*, as practiced in Asia] is now practiced to its full extent; and water here shows a power of production with which we are unacquainted in more humid and temperate climes. At this time the barley and wheat are shooting up simply under the power of water, which is conveyed to them by small ducts of earth drawn up from the wells. Every four or five days a bullock or slave draws up the water from the wells, which are of a very rude construction, but answer the purpose. The water is then poured into a receiver of earth or stone, from which it runs into the small conduits of earth. Sometimes the main conduits are made of lime mortar, as in the island of Jerbah. The field to be irrigated is divided into small squares, or compartments, sometimes oblong, of only about 7 by 5 feet in size; each is edged up with a small embankment of earth; between each line of squares run parallel ducts or gutters of earth, communicating with one large and common conduit, which is usually placed, to run better, on the highest part of the field, and as nearly as possible cut into halves. Whilst the water is being drawn up, a lad opens each compartment of the field with a hoe or shovel hoe, and lets the water into each square, shutting it up again when the surface of the ground is merely covered with water. I have seen them tread upon the springing blades of grass when so irrigating them, to give their roots more force and tenacity in the ground. In Ghat this irrigation is repeated every five days, or less, until the grain is in the ear and nearly ripe."

Mr. Sirr, in his account of China, speaking of Chinese irrigation, says: "The sugar plantations in China are allowed to be of a very superior description; and we are induced to believe, from the statements made by West Indian and Cingalese planters, that to the superiority of Chinese irrigation the excellence and flourishing condition of their plantations and canes is due. The mode adopted is that of conducting water through trenches from the large reservoirs, which are placed between each row of canes; and at regular intervals the water is allowed to pass through transverse trenches; these trenches are either opened or closed, as the canes in their respective securities require moisture."

The mode of irrigation practiced in Caubul is thus described by the Honorable Mount Stuart Elphinstone, (vol. i, p. 396–'8,) in his account of the kingdom of Caubul:

"The most general mode of irrigation is from streams, the water of which is sometimes merely turned upon the fields, but oftener is carried to them by little canals. It is diverted into those channels by dams, which, in small rivulets, cross the bed, and are swept away in the season when the water rises. In larger rivers, a partial embankment is made on one side which extends for a certain distance into the current, and which, though it does not entirely interrupt the stream, yet forces a part of it into the canal. From the canal smaller water-courses are drawn off into the fields, which are bounded by little banks raised on purpose to retain the water.

"The next contrivance for obtaining water is the sort of conduit which is called *cauraiz*, or *caureez*. It is known by the same name in Persia, but is there most frequently called a *kaunaut*. It is thus made: the spot where the water is to issue must always be at the foot of a slope extending to a hill, and the ground must be examined to ascertain whether there are springs and in what direction they lie. When the spot is fixed, a very shallow well is sunk, and another of a greater depth is made at some distance up the slope. A succession of wells is made in this manner, and connected by a subterraneous passage from well to well. The wells increase in depth as the ground ascends; but are so managed that the passage which connects them has a declivity toward the plain. Many springs are discovered during this process, but the workman stops them up that they may not interrupt his operations until he has finished the last well, when he opens the springs, and the water rushes through the channel, rises in the wells to the height of its source, and is poured out from the lowest into a watercourse which conducts it over the fields. When the *caureez* is once completed, the wells are of no further use, except to allow a man to descend occasionally to clean out the channel. The distance between the wells varies from ten yards to a hundred. It is usually about fifty. The dimensions of the channel are generally no more than are necessary to allow the maker to work, but some are much larger. I have heard of a *caureez*, near Subzewaur, in Persian Khorassaun, through which a horseman might ride with his lance over his shoulder. The number of wells, and consequently the length of the *caureez*, depend on the number of springs met with, as the chain is generally continued, either till water enough has been obtained, or till the wells become so deep as to render it inconvenient to proceed. I have heard of various lengths from two miles to thirty-six, but I should suppose the usual length was under the lowest of these measures. * * * *Caureezes* are very common in all the west of the country, and their numbers are on the increase."

In the Journal of the Royal Agricultural Society, vol. v, (1844,) p. 287, the following account is presented of the mode of procuring water for purposes of irrigation in Afghanistan, evidently similar to those described by Mr. Elphinstone:

"All the high mountain peaks in the valley of Kojick and Pisheen are covered with snow in March and April. The valley slopes from north to south, and also from east to west. It is studded with villages, which are hid among gardens and orchards, and is a lovely plain, being refreshed with sweet waters and clothed with luxuriant vegetation. It is intersected by numerous small canals and water cuts, which are supplied by means of *khareez*. These *kharees*, upon which so much depends in Afghanistan, consist of a number of shafts, or wells, sunk in the upper part of the plain, where there is water, until they meet with springs. They are connected at the bottom by subterraneous galleries, and the whole united in one canal, which is carried under ground down the valley, at nearly the same level, or at least with only a sufficient slope to cause the water to flow; while the slope of the country being so much greater, the canal of course gradually emerges to the surface. Wells are sunk along the line at the distance of every fifteen or twenty yards, through which the soil is brought up from the canal, and air admitted to the workmen. They are never closed, but remain a line of open wells marking the course of the canals under ground, which are often of great length, being many miles. When the canal makes its appearance on the surface of the country, and becomes an open water-course, it is often carried for twenty or thirty miles, fertilizing the country through which it passes. A number of these *khareez*, which unite together at a place called Sir-i-âb, or Head of the Spring, a few miles north of Kmetlah, form the source of the Shadeezy Lora river; a considerable stream, of great importance to the country, being thus in a manner artificially formed."

Some idea of the history and progress of irrigation in different parts of the world has been herein presented, together with such a summary of collected views in relation to its action, the modes of conducting it, and the advantages it offers to the husbandman, as may be useful to our own agriculturists. Little or nothing, comparatively, seems to have been done or attempted, or is even generally known, in our own country, in respect to the practice of irrigation; and yet no land, probably, presents better opportunities for realizing its great benefits at little cost. Were the attention of our farmers and planters directed to the subject, and were they to make a real trial of the methods that have been practiced, according as the situation of the ground, its soil, surface, and other circumstances suggest, it is confidently believed they would reap great profits from well-conducted systems of irrigation, on a larger or smaller scale. Considerable interest has been excited in regard to drainage; and the good results which have accrued from its introduction justify the recommendations with which it has been often pressed upon the notice of agriculturists by the agricultural journals, and in public addresses, and lectures before agricultural societies. Let an effort be made now to urge upon our intelligent farmers this kindred subject of irrigation, and equal success, it cannot be doubted, will soon reward the labors of those who enter upon it with the prudent and resolved aim to avail themselves of all the means at their disposal to secure its full and rich fruits, in the fertility of their fields and increased value of their crops.

Such an awakening to its importance would soon call forth the ever-accumulating testimony of experience, and create a demand for the best practical treatises, which might at little cost be found on the shelves of every book-shop, and would probably add millions to the productive income of our agricultural resources, turning the most barren spots into well-watered gardens, and clothing with deep verdure many tracts of country on which poverty-stricken laborers now gather but a meagre recompense for their industry. Even in what has been herein given in the details of actual experiment, there is that doubtless which ought to make many a farmer and planter resolve that resources so easily turned to profit, but now utterly wasted, shall be made to yield of their strength and power to add to his fields and pastures a richness and fatness they have hitherto never exhibited; and thus, too, at once enlarging the material and permanent wealth of an industrious and intelligent population.

GRASSES FOR THE SOUTH.

BY REV. C. W. HOWARD, ASSOCIATE EDITOR OF THE SOUTHERN CULTIVATOR, KINGSTON, GEORGIA.

As this Essay is designed to be an inquiry into the adaptation of the South for the cultivation of the grasses and into the different kinds of the grasses best suited to a Southern latitude, many things will be found in it without interest to a Northern reader. In fact,

statements will be made which, though true at the South, would be untrue at the North. The purposes of grass culture at the South and the North differ widely from each other. At the North the chief object is hay as a supply for winter. At the South the desideratum is the cultivation of those grasses which will grow during our mild winters, and therefore save us the expense and labor of making hay. Hence it will be seen that recommendations which will hold good in one section will not always hold good in the other.

As this Essay is designed for general readers, it will not be a Botanical Essay. Whenever it is possible, the common popular names will be applied to the grasses considered.

I.—IMPORTANCE OF GRASS CULTURE TO THE SOUTH.

In no part of Christendom, enjoying a good government, and settled by an intelligent population, does land sell at so contemptible a price as in the Plantation States. In Georgia, for instance, land does not command an average price of five dollars per acre. Various causes have been assigned for this low value. It will be instructive to examine them.

The reason generally assigned at the South is the proximity of an abundance of cheap fertile lands at the West. If this be a sound reason at the South, it should also be true at the North, as it is as easy to reach new lands from New York as it is from Georgia. But land is steadily rising in value in New York and other northern States. The proximity of new lands cannot, therefore, be the cause of the low price of land at the South, as it does not produce this result at the North.

It is said, again, that the supply of land is greater than the demand, in consequence of the sparseness of our population; capital seeks its most profitable investment. There is money enough in the Southern States to have given a much higher value to our land. But the truth is that prudent men have found that, under our present system, land will not pay an interest on more than its present price. Hence this capital, instead of being invested in land, is appropriated to the building of railroads, factories, &c. It will also be found that in the Southern States where the white population is least dense the lands are highest in price, and the reverse.

Many persons suppose that it is the form of labor prevalent at the South which diminishes the value of Southern lands. This supposition is worthy of a brief consideration.

The remarks made upon it will not touch the moral or political aspect of Negro Slavery; it will be considered merely as a matter of agricultural interest.

If Negro Slavery diminishes the value of Southern lands, it must produce this result in some one of the following forms.

Before noticing these forms it may be proper to make the general remark that at the South where the negroes are the most numerous the lands bear the highest price, as the rice, Sea Island cotton, and sugar-cane lands. Some of our best rice lands now command from two hundred to three hundred dollars an acre. The reason of this high price will be given hereafter.

Does slave labor affect injuriously the value of Southern lands from its want of constancy? It is the most constant form of labor. The negro has no court-house, no jury, no musters, no mill to attend. He has no provision to buy, and no anxiety or loss of time on this account; food for himself and family is provided. If his family are sick, careful nurses are provided for them. The details of cotton and rice culture could not be conducted with a form of labor less constant.

Is there a deficiency of vigor in slave labor? In all forms of out-of-door bodily and severe labor, to be continued for a length of time, the well-fed negro is more capable than the white man. The regular and almost universal allowance of food upon plantations shows that, as a general rule, the negroes have a sufficiency of hearty and nutritious food.

Is there a deficiency of intelligençe in Slave labor? There is less intelligence than among white laborers at the North, in Scotland, and some parts of England; but not less intelligence than exists among the mass of French, Irish, and Belgian laborers. Yet land rates as high in Belgium as in any other part of Europe. The cultivation is also as perfect as can be found elsewhere. It is not so much the intelligence of the laborers as of the controlling and directing mind, which is of the greatest moment in agriculture.

Is there a deficiency of economy in slave labor? The entire expense of a negro laborer on a plantation cannot be put down at more than fifty cents a day. Can any other labor in this country be obtained as cheaply as this? Beyond this, multitudes of men have largely increased their fortunes by the natural increase of their laboring force.

If there be no deficiency in the constancy, vigor, intelligence, or economy of slave labor, it cannot be supposed, with justice, to affect the value unfavorably of Southern land.

In the present excited state of the public mind it is proper to repeat the remark that this brief inquiry is made, not with a view to exciting discussion of a vexed topic, but solely of arriving at the true cause of the low price of Southern land, and of suggesting a remedy.

This inquiry could not be conducted without an examination of the character of the labor employed upon the land.

Does the Southern climate affect injuriously the price of Southern lands? It does not; because the lands are of the greatest value [greater than anywhere else in the Union] in those parts of the South which are not sickly, as the rice lands. As a general remark, the climate of the middle belt of the Southern States, including rolling oak and hickory lands, very closely resembles the climate of France, which is considered to be the best climate of Europe for agricultural purposes. In most of this region there are but few days in winter in which the plough need be stopped on account of the frozen state of the earth.

Is there a deficiency in the natural fertility of the Southern soil? No one will pretend to say that the original fertility of the great body of the Southern States was inferior to that of the Middle and Northern States, where land has attained a great comparative value.

Is there a deficiency in the salable value of Southern products of the soil? These products generally command a better price at the South than the North. The most valuable products of the South, cotton and rice, are peculiar to it.

If the low value of landed estate at the South is to be attributed neither to the proximity of cheap Western lands, to slave labor, to defective climate, to sparseness of population, or deficiency in the value of its products, to what is this low value attributable?

The answer is, to the *Defective System of Southern Agriculture.* That system is defective, among others, in the following particulars:

1st. This system is such that the planter scarcely considers his land as a part of his permanent investment. It is rather a part of his current expenses. He buys a wagon and uses it until it is worn out, and then throws it away. He buys a plough or hoe, and treats both in the same way. He buys land, uses it until it is exhausted, and then sells it, as he sells scrap iron, for whatever it will bring. It is with him a perishable or movable property. It is something to be worn out, not improved. The period of its endurance is therefore estimated in the original purchase, and the price is regulated accordingly. If it be very rich level land, that will last a number of years, the purchaser will pay a fair price for it. But if it be rolling land, as is the great bulk of the interior of the Southern States, he considers how much of the tract is washed or worn out, how long the fresh land will last, how much is too broken for cultivation, and in view of these points determines the value of the property. Of course he places a low estimate upon it.

2d. The system of Southern agriculture is such that a very large proportion of the landed estate yields no annual income. A considerable amount is in woodland, yielding nothing but a supply of rails and fuel. This is to a great degree dead capital. A large number of acres on almost every farm in the older parts of the cotton States is worn out and at rest—of course paying no interest. The only paying part of the tract is that which is under the plough. The interest on the land which the planter does not cultivate must be charged to that which he does cultivate, and this brings down the value of the whole property to a very low figure.

3d. The Southern system of agriculture allows to land no value independent of the labor put upon it. The negro is the investment rather than the land. The value of the negro is instantly affected by a change in the price of cotton, while the value of the land which grows the cotton is comparatively unaffected. It is an extraordinary anomaly that perishable labor should take precedence of imperishable land. It is not uncommon to hear young men at the South giving it as a reason for their entering a profession, that while they owned a large body of land they owned but twenty or thirty negroes, and that it would be impossible to make a support with so small a force. When asked how the rest of the world manage who have no negroes, the reply is "our system differs from theirs, ours requires a large amount of labor."

Precisely, and therein it is defective, and until that defect be remedied, land will continue to be comparatively a drug in the market. It is the design of this Essay to show that it is possible to give land a value independent of any costly or complicated annual labor bestowed upon it.

4th. The Southern system of agriculture includes a succession of crops of a most exhausting or otherwise injurious character. These crops are cotton and corn, varied only by small grain. This succession is continued until the land is worn out and turned out to rest.

5th. These crops are not only exhausting and hurtful in consequence of the clean culture they require, but they also require an amount of labor not known elsewhere. If we consider the amount of productive land, that is, the number of acres yielding an annual income, we shall find the amount of labor used on an ordinary Southern plantation to be greater per productive acre than the amount of labor used in the most perfectly cultivated portions of Europe. In the latter every acre produces something, whether in pasture, meadow, or cultivated crops. At the South nothing but the cotton or grain pays. The rest of the plantation is idle.

The causes mentioned are those which have the greatest influence in depreciating the value of Southern land. They are as follows:

The planters buy land as something to be worn out, not improved; they suffer a large portion of their investment in land to remain as dead capital paying no annual income; they pursue a system which allows no value to their land independent of the labor bestowed upon it; they cultivate a succession of crops of an exhausting or otherwise hurtful character; and, lastly, in the cultivation of these crops, they use an amount of labor not known elsewhere in intelligent agriculture.

The people of the Southern States must be in all time chiefly an agricultural people. Their land must be the basis of their wealth. Upon its skilful use must rest their permanent prosperity. Large and remunerative crops at the expense of the land indicate a prosperity which is fallacious. It is living upon capital. That which gives the greatest value to their land most conduces to their permanent prosperity. There is no question of political economy of equal importance to the people of the South as the best means of increasing the value of their landed estate. For instance, there are in the State of Georgia, selected because the writer happens to be most familiar with it, about thirty-seven millions of acres of land. An average increase of value of ten dollars per acre, which would not bring its salable value to fifteen dollars per acre, would give an increase to the property of the State of three hundred and seventy millions of dollars—a sum larger by more than fifty millions of dollars, than the whole value of the personal and real estate of Georgia by the census of 1850—an increase which would yet leave the land of the State worth less by thirteen dollars per acre than the average value of land in the Middle States.

The remedy proposed for this depreciation of Southern land is *A Change in the System of Agriculture prevalent at the South.*

When a change is spoken of, it is not meant to advise an abandonment of any of our staples. The world requires southern cotton, rice, and sugar. It cannot now dispense with them. A total failure in the cotton crop would create, if not a revolution, a fearful disturbance of affairs in England.

The change proposed is the incorporation into the Southern system of agriculture, of a feature by which crops for the improvement of the soil shall receive as regular attention as crops for sale.

Prominent among these crops are the artificial grasses. By them, most profitably, sufficient live stock can be raised to keep in a state of progressive improvement the lands cultivated in cotton or the cereals. By their use the whole of the farm becomes productive. There is no dead capital in it. The soil is prevented from washing or exhaustion. An equal area may yield an income with much less labor.

In fact, a portion of the farm yields a fair income without annual labor, save the cost of keeping up the fences.

As a confirmation of the truth of these remarks, if we take the map of Europe, we shall find that land rates in price in proportion to the attention paid to the artificial grasses. It is least in Spain; it rises in France; it is still greater in Belgium, and greatest in Holland, which is almost a continuous meadow.

If we take our own country, the same observation holds good. Passing by the older Northern States, let us compare Kentucky and Georgia. The Kentucky lands, as a general remark, are much better naturally than those of Georgia. But there are some bottom lands in Georgia equal to the best of the Kentucky lands, leaving out the rice lands. We can easily find any of the best bottom lands in Georgia which will command more than fifty dollars an acre, while farms sometimes sell in Kentucky for more than one hundred dollars an acre. Both are slave States. Kentucky is younger than Georgia. She is nearer to the new lands of the West than Georgia. Her climate is not so good as the climate of Georgia. The cause of the difference must be found in the different systems of cultivation adopted by each. Every acre of the Kentucky farm, including woodland, produces something, as all the land not under the plough is in grass, yielding a return without labor. On the contrary, no acre of the Georgia farm produces, except that which is under the plough, and the farm does not contain within itself, under the present system, the means of repairing the damage done by the plough. The cause of the difference, then, between the Georgia and Kentucky land of equal fertility in value is obviously the reason above given.

This is the proper point to allude to the exception afforded by the rice lands and some of the Sea Island lands. Both of these have the means of keeping up their fertility within themselves. If they did not possess these facilities, they would quickly fall into the condition of the rest of the Southern lands. The rice lands can keep up their fertility by flooding with water; the sea islands by using the marsh mud which surrounds them. They are to a degree independent of live stock. The rest of the South must look to live stock as their only permanent reliance for keeping up the fertility of the lands. All experience teaches that there is no way of keeping live stock in sufficient numbers to answer this end but by the aid of the artificial grasses, which follow and do not precede the domestic animals. All grasses are considered as artificial grasses which it is necessary to sow.

II.—CAN THE ARTIFICIAL GRASSES BE GROWN IN THE COTTON STATES?

A great many things are now done at the South which, a few years since, were deemed impracticable. It was supposed that winter fruits could not be raised at the South. The reason was that the experiments were made with trees suited to a Northern climate. It is now conceded that the Southern apples and pears for winter use quite equal the Northern. It was supposed that wine could not be made at the South, yet Southern wines cannot be exceeded in this country. It was supposed that malt liquors could not be made at the South, yet beer of excellent quality is made here. It was supposed that cheese could not be made at the South, yet as good cheese as any made at the North has been exhibited at our Fairs. It was supposed that wool of the Saxon and merino sheep would deteriorate in the climate of the South, yet at the World's Fair in London, Tennessee wool took the premium over all competitors. We should never conclude that a thing cannot be done because it has not been done.

It is said that the climate of the South will be an effectual barrier to the extensive growth of the artificial grasses. These grasses make up a large class. There are several hundred of them—some belong to a cold climate, and some to a warm climate, some requiring a damp soil, and others a dry soil. There is as much difference in their habits as there is in the habits and wants of fruit trees. Because the fig and pomegranate will not grow in Massachusetts, shall we conclude that no fruit trees of any kind will grow there? And because a Northern artificial grass will not grow in a Southern soil, shall we conclude that no artificial grass will grow there?

The Southern climate has its advantages and disadvantages in grass culture. At the North the danger is that the grass will be frozen out, at the South that it will be burned out. Proper precautions must be taken in both instances. A traveller passing through the Southern States in July, and finding the grass parched under the summer's sun, may, on his reaching the North in the same month, find their meadows looking green and refreshing, and may conclude that grass culture succeeds in the North, but is unsuited to the South. But suppose the same traveller finds in the following March that the land at the North is stiff frozen or covered with snow; that the cattle are all housed and eating costly food; and when he reaches the South in the same month, finds the pastures green and verdant, and the cattle luxuriating in new grass, might he not with the same propriety conclude that the North was a bad grass country, and the South a good one?

The hot suns of the South are against the grass in the summer, but they are very much in its favor in the winter. Almost all the Northern grasses which will live at the South change their habits and become winter grasses. They grow during the winter. It cannot be expected that they should grow during the summer. Everything which the Almighty has made, possessing either animal or vegetable life, requires some period of repose. These grasses, which have so changed their habits as to grow during the winter, must not be grazed during the summer. Nor must they be so closely grazed during the winter that their roots will be left in a denuded state to encounter the hot sun of the summer, which will keep them. They must be allowed to rest from their winter and spring labors under a cover of a portion of their own vegetation.

The ability to use the artificial grasses during the winter is a great advantage of the Southern climate. It amounts to letting the stock mow their own hay, and is a saving of the expense both of mowing and of expensive barns. The cost of one Pennsylvania stone barn would lay down a considerable Southern plantation in the winter grasses. The substitute in the summer is the crab grass, which springs as soon as the grain is cut, and affords a bite of fresh young grass at a time when, in countries destitute of this invaluable product, cattle feed reluctantly on the old grass of the spring.

It may be said by some of the readers of this Essay, "This is fair theory, but we have tried these grasses at the South, and they do not succeed." Perhaps the experiment has been made on poor land. Neither cotton, corn, nor grain would succeed if put on poor land and left without subsequent attention. The great body of the Southern States was once covered with a carpet of nutritious grasses, as Texas now is. They were then natural to grass. Most of these grasses have disappeared from among us. The pea vine once grew on land now too much exhausted for profitable cultivation without manure. The history of a range is as follows: When the stock of the settlers first enter it they attack only the grasses which they like. They continue these attacks from year to year, beginning as soon as the first bud of the spring puts forth. They leave the grasses which they do not like. These flourish while the valuable grasses are destroyed. Hence we may go into a range in the newer parts of the South, and while the ground is covered with grass in August almost knee-high, we shall find the cattle hungry in the midst of apparent plenty.

Cultivation adds to the destruction of the valuable natural grasses. The salts necessary to them are exhausted by it. And if we wished to replace these grasses upon the soil on

which they once flourished, it would be absolutely necessary to manure it heavily. The careful observer will occasionally find some of these grasses growing in the older parts of the South, but always in rich places in which they have by some means been secured against the exterminating "hoof and tooth." If it be necessary to manure the land in order to make valuable grasses grow which were once native to it, how much more is it necessary to manure the same land in order to make grasses grow which are foreign to it. The artificial grasses are highly concentrated food. They contain much in a small space. They are composed of the elements which make up the flesh and bones of the animals which eat them. They must previously feed before they can feed these animals. If the grass food is not in the soil, it must be put there. There is no crop on which manuring pays better than on grass lands, as it pays twice—in the profit on the animals fed and in the improvement of the soil. Most of the unsuccessful experiments in grass culture in the South have been unsuccessful because they have been made on poor land.

Good bottom land at the South will generally produce the grasses suited to them without the aid of manure. There is very little cultivated upland in this country which will produce good grass crops without manure. These exceptions are generally found in the West and Northwest. They rarely, if ever, occur at the South.

The question is asked, Will it pay to manure grass lands at the South? If it will pay anywhere, it will certainly do so here. If it will pay to manure a meadow at the North, from which hay is to be cut, cured, carted, and stacked, or housed, much more will it pay at the South, where all this expense can be saved by an advantage of climate. The person who is considering grass culture at the South on upland, must take into the account the cost of manuring as an indispensable preliminary. On open land this cost may be abated and sometimes more than compensated by sowing grain with grass seeds, the increase of the grain crop covering the expense of the manure.

Persons attempting the cultivation of the grasses at the South have sometimes failed, because they did not understand the nature of the perennial grasses. They are accustomed chiefly to the annual grasses, as the crab and crowfoot grasses. These mature rapidly, as they are short-lived. It is a law of nature that those of her products which are designed to last long mature slowly. The planter will recognize an illustration of this remark in the growth of a broom sedge field. The first season the young grass barely makes its appearance, yet it is there. It is several years before it entirely occupies the ground. The same field, if ploughed, would spring up in crab grass, and in two months would be covered with a heavy carpet of grass and annual weeds.

When a field is sown with the artificial grasses at the South, the first season the groun will apparently be occupied almost exclusively by the natural grasses and weeds which always follow the stirring of the soil by the plough. The experimenter, observing this result, concludes that his experiment is a failure and ploughs up his ground.

He should have remembered that these grasses and weeds are annuals; that they follow the plough; that they will not appear the next year, and that they have shaded from the scorching sun the delicate needle-like spears of the young perennial grasses which are hardly visible to his eye. He should have waited until the next year, when he would probably have found a fair stand of the grass sown by him. Again, some experimenters in grass culture, delighted at the succulent appearance of the young grass in the autumn, when everything else has been withered by frost, turn upon it their equally delighted animals. These continue upon it all winter, wet or dry. A blade of grass which appears above ground is instantly bitten. This process is repeated until late in the spring. The summer's sun comes, the naked roots are exposed to it, the grass is killed, and the experimenter declares that the Southern climate is unsuited to any of the artificial grasses.

These failures, whether from the selection of unsuitable grasses, from sowing in poor land, from ignorance of the comparatively slow growth of the perennial grasses, or from overstocking and too close feeding, are all set down to the climate.

The writer has given for more than twenty years a considerable degree of attention to the growth of the artificial grasses at the South. He does not hesitate to give it as his opinion, based upon long observation both in all parts of this country and many European countries, that, for the production of several of the most valuable grasses, the climate of the Southern States possesses advantages which are not exceeded by any other climate whatever—the temperature of the whole year being taken into the account. Our deficiency is much more in fertility of soil than in suitableness of climate. A disadvantage of climate is irremediable by man; a disadvantage of soil may be remedied by skilful culture.

III.—WHAT ARE THE GRASSES SUITED TO THE SOUTHERN STATES?

Failures are often as instructive as successes. To save labor and expense to others, a statement will be made of the results of all the experiments in grasses and forage plants made at Spring Bank Farm.

This farm is situated near Kingston, Cass county, Georgia. It is in what is called the

blue limestone formation. The soil is a stiff, red clay, having in it a very small quantity of sand. Except the bottom land, it has been manured where most of the experiments have been made. Latitude between 34 and 35 degrees.

FORAGE PLANTS.—1. Sainfoin.—From the great value of this plant in the South of Europe it was hoped that it would prove an acquisition to Southern agriculture. Seeds have been sowed on this farm obtained from England, France, and Naples. They have been sowed, at intervals of time, on upland and low ground, on manured and unmanured land, on limed and unlimed land, and in no instance with success. The plants have lived, but their existence has been a sickly and useless one.

2. Burnet or Pimpernel.—This plant does not grow here high enough to mow. It is green all winter, being scarcely touched by our severest frosts. It is not liked by stock during the summer, but is readily eaten during the winter. It is worthy of more extended trial than has been given it here. It grows in tufts or bunches; its blood-red blossoms, with their peculiar round form, (from which it derives its name, "Sanguisorba,") render it an ornamental plant."

3. Lupine.—This was another plant from the South of Europe, from which much was expected. The plant has grown vigorously here, but soon after the formation of the beans it was attacked by an insect, which touched nothing else, and destroyed it. A similar insect has followed several other experiments with this plant in Georgia. Besides being subject to this casualty, it is an annual which diminishes its value even where it can be successfully grown.

4. Vetch.—Experiments have been made with both the English summer and winter vetch. They have grown very well, but do not produce as much as the better sort of our field peas. These are also annual. There is a native vetchling which is propagated with ease, which comes earlier than any other forage plant except lucerne. This is an insignificant plant on poor land, but on rich land grows more than knee-high and makes a fine hay. Its best use is to be sown with winter grasses for pasture; after once being sowed, resowing is not necessary unless it be grazed too severely. It is now becoming generally diffused over this farm.

5. Scabious.—This is a forage plant much valued at the cantons of the Cevennes. Besides being nutritious, it is believed to possess valuable medicinal properties for live stock. It is known in our flower gardens under the popular name of "Mourning Bride." It has not been found here to stand grazing, and does not answer for hay.

6. Chicory.—Arthur Young speaks with enthusiasm of this plant: "I never see this plant," says he, "this excellent plant, without congratulating myself for having travelled with the view of acquiring and spreading useful knowledge." According to him the introduction of this forage plant into England, if a man had done nothing else during his life, would be sufficient to prove that he had not lived in vain. In the Southern States it certainly does not promise equal benefits. It grows with vigor; stock are fond of it when cut and thrown to them. But it is propagated too slowly, and requires too much culture for the present state of Southern agriculture. Such at least is the conclusion based upon the experiments made with it upon this farm.

7. French crimson clover.—This is a beautiful annual when in blossom, resembling a field of large ripe strawberries. On rich land it thrives well during winter and spring, and affords early and valuable pasture. As a fertilizer it would be valuable sown with wheat on land already in good heart. The seeds differ from the common red clover in being enveloped in a kind of down, which enables them to be diffused by the wind.

8. Neapolitan clover.—This species closely resembles the preceding. Both the plant and the seeds are somewhat larger. It is also an annual, and its value is diminished on this account.

9. Spurry.—This plant, which has been called the "clover of sandy lands," has been unsuccessfully tried at this place. The growth was meagre and valueless. It is possible that it might thrive on lands containing more sand.

10. Melilot.—Two species of melilot have been experimented upon; one an annual having yellow blossoms, the seeds of which were obtained on the Battery at Charleston, S. C. It grows luxuriantly here, but is rejected by all kinds of live stock. The other kind, with white blossoms, is a biennial, growing on rich land four or five feet high; it is also rejected by stock. It is a singular fact that this foreign plant was in use by the Cherokee Indians before this country was taken possession of by the whites. It was valued by the Indians as a fragrant ingredient in a salve in much repute among them.

11. Narrow-leaved plantain.—This plant is regarded as a pest at the North. In England, on the contrary, it is much valued, particularly in Yorkshire, where it passes under the name of ribwort. Almost all the cloverseed brought to the Southern States from the North contain seeds of the plantain. It will live at the South on the poorest land, but is valuable only on good land. If not grazed during the summer it will afford a considerable amount of winter food. Cattle, horses, and sheep eat it in winter with avidity. Hogs are not fond of it. It is a useful constituent of a winter pasture at the South, and its growth is therefore encouraged on this farm.

12. White clover.—This is an invaluable plant in Southern agriculture. It springs naturally in almost every place on which ashes have been thrown, and which have been left for any length of time, without cultivation. Its benefits are not generally known, because the spots on which it grows are generally thrown open to cattle all the year round. They are very fond of it, and it is therefore rarely suffered to attain its full height. On this farm, if not grazed during the winter and spring, it grows on manured land sufficiently tall to mow. If sowed with tall grasses for hay, it stretches in its efforts to obtain its share of light, and thus gives a heavy cutting near the ground. Its tendency at times to slabber horses is an objection; but this objection is trifling when compared with its many advantages. It is very valuable as a hog and sheep pasture, as it grows during the warm spells in winter in this latitude and below it. It thrives on any land that is rich enough for it, growing as well on the sandy lands near the coast as on the dry lands of the interior. It is of much use as a fertilizer. When a piece of ground has been made rich enough to bear a good coat of white clover, which is suffered to shed seeds, it becomes as natural to the soil as crab grass. The process of subsequent improvement is easy. It yields little summer pasturage. It possesses an interest to the Southern planter, as it will thrive on sandy soils on which red clover will not live. It should be sowed with some of the grasses. It combines admirably well with Bermuda grass, as the white clover appears as the Bermuda ceases to grow in the autumn. The extensive cultivation of this apparently insignificant though really valuable plant is strongly advised.

13. Red clover.—It is unnecessary to speak of the value of this forage plant. This is universally known. The only question is, Will it grow at the South? Careful inquiry, experiments, and observations have determined the following results in regard to it: It will grow on rich and dry bottom lands in all parts of the South. It will not thrive in a wet subsoil, however rich the surface may be. It will thrive on any of our lands made sufficiently rich and ploughed to a sufficient depth. Deep ploughing is essential, in order to enable its tap root to sink rapidly into the earth. On lands destitute of clay, it is useless to attempt its culture. Clay lands which have been worn by cultivation must be well manured in order to grow red clover successfully. It will die out if pastured much, under our fiery sun, after the month of June. It should be suffered to remain untouched during the summer, and be grazed again as cool weather commences. Red clover possesses a peculiar advantage to the Southern planter, not to cut for hay, but chiefly as a hog pasture in the spring, to last until the stubble fields are open. One of the greatest expenses of the plantation is the cost of meat for the negroes. This meat, during the greater part of the year, is bacon. The most troublesome season of the year in hog raising is the spring. Red clover meets the wants of that season. Every planter should sow enough red clover to graze his hogs at that time. There is scarcely a plantation in which suitable land cannot be found. Of it as a fertilizer in a rotation of crops, it is unnecessary to speak. It grows well at the South in woodland which has been well thinned out, and the ashes from the burned timber and brush carefully scattered.

14. Lucern.—On many accounts, Lucern is one of the most bountiful gifts of Nature to the Southern planter. No grass or forage plant in cultivation at the North will yield nearly as much hay as Lucern at the South. In good seasons, and on land sufficiently rich, it can be cut four or five times during the year. An acre of good Lucern will afford hay and cut green food for five horses the whole year. Ten acres will supply fifty head of plantation horses. This can be cut down in a day with a mowing machine. How unwise in the planter, then, to damage his corn by pulling fodder—that most irksome and senseless work of the plantation. A few acres of Lucern would save him this labor, and the tedious time occupied in pulling fodder could be employed in the improvement of his land. It is useless to attempt the cultivation of Lucern on poor land. It will live, but it will not be profitable. There are certain indispensable requisites in the cultivation of Lucern. The ground must be good upland; it must be made very rich; it cannot be made too rich. If the ground is as carefully prepared for it as an asparagus bed, the Lucerne will spring almost with the rapidity (after cutting) of asparagus. It must be very clean. When the Lucerne is young it is delicate, and may be smothered with the natural weeds and grasses of a foul soil. Land which has been in cotton, worked very late, if made sufficiently rich, is in a good state of preparation for Lucern. The manure put upon it must be free from the seeds of weeds; hence, a mixture of guano and phosphatic manures would be an excellent application. On this farm, land designed for Lucerne is put in drilled turnips well manured and worked. The turnips are folded with live stock—that is, they are fed on the ground, which thus gets all the solid and liquid excrements of the animals, and becomes very rich, and is also very clean.

Great depth of cultivation is necessary in preparation of the soil for Lucern. If the ground was broken up with a four-horse plough, and in the same furrow a two-horse subsoil plough was run, stirring it eighteen or twenty inches, it would be to the advantage of the subsequent crops of Lucerne.

Ten pounds of seed are required for an acre, sowed broadcast. Drilling is unnecessary if the ground be properly prepared and the Lucern is not pastured. If the preparation has been imperfect, and the Lucerne is to be occasionally pastured, it is better to drill at such a distance as will allow a narrow plough to be passed between the rows when the surface requires stirring.

Either early in autumn or early in February are good seasons for sowing Lucern. The seed should be lightly harrowed in, and then the surface should be rolled. Lucern lasts a great number of years, the roots ultimately becoming as large as a small carrot. It should be top-dressed every third year with some manure free from the seeds of weeds. Ashes are very suitable for it. The Lucerne field should be as near as possible to the stables, as work-horses, during the spring and summer, should be fed with it in a green or wilted state. As Lucern is much earlier than red clover, it will be found a useful adjunct in hog raising. Hogs are very fond of it, and will thrive on it in the spring, when it is cut green and thrown to them. This extended notice of Lucern is given because it is remarkably adapted to our soil and climate, and is, beyond all comparison, the most valuable plant for hay-making and soiling to the Southern planter. It thrives in no part of Europe with greater vigor than it does in the Southern States.

It will be seen from the necessarily brief remarks upon these fourteen different forage plants that the writer has bestowed much attention upon this interesting branch of agriculture. His observations are not taken from books, but are the result of personal examination and experiment. Some of the seeds of these plants have been obtained with a good deal of trouble. When some of these plants, the seeds of which had been obtained from England, failed, it was supposed to be possible that the failure might have arisen from the fact that the seeds were grown in a climate different from our own. A second trial was therefore made with seeds obtained direct from Italy. The result has been given. The whole of them are rejected as being not deserving of attention at the South, except Lucern, red and white clover, and possibly burnet.

The Grasses.—The reader should bear in mind that when grasses are represented as growing successfully at the South, it is to be understood that they were sown on land either naturally or artificially rich. He will be misled if he applies the conclusions hereinafter stated to poor land.

15. Blue Grass.—This well-known grass will grow at the South on all lands having a good clay foundation. On extremely rich land, if not grazed during the summer or autumn, it will yield a tolerable burthen of green food during the winter.

Its ordinary growth is low. It almost disappears during the heat of summer. It has a great tendency to become, in common language, "hide-bound." Its chief value is when sown with other grasses which grow in tufts, as orchard grass, as it fills up the intervals between these tufts. It should not be suffered to find its way into meadow land designed for hay. On rich bottom land it will overrun almost any other grass than Bermuda. It rarely grows at the South high enough to be cut, and it therefore converts a meadow into a pasture. It grows best in woodland. It should not be sowed alone, but in connexion with other grasses, and is valuable when thus used.

16. Orchard Grass.—This grass succeeds at the South on lands having a clay subsoil, as low down as the oak and hickory rolling country extends. In the flat sandy lands it is said not to perfect its seeds, and quickly dies out. It is of little use at the South as a hay grass, but possesses great value as a winter pasture. It grows best in the shade, which result its name would indicate. It should not be grazed during the summer. All stock should be taken from it in June and not allowed to return to it until Christmas. It is not among the most permanent of the artificial grasses. Hence it is proper to sow it with red and white clover, when these are used in a rotation, for the improvement of the soil. Orchard grass is proper to be mixed with clover, when the latter is to be cut for hay, as both blossom at the same time. Herds grass and timothy are much later than red clover, and therefore unsuited to be sown with it.

17. Timothy.—On rich bottom lands, well drained, timothy succeeds well, generally, at the South. Recent experiments near Atlanta and Athens, in Georgia, indicate that it will grow satisfactorily on manured upland. There are other grasses which will yield more hay on upland, and several others which will afford better winter pasture. It is advised to confine its use to rich bottom lands and for hay.

18. Tall meadow Oat-grass.—This grass has been introduced into Georgia under several names: the Stanford wild oat, the Snythe grass, the Utah grass, and the Oregon grass. These are the same grass. The seed stems of this grass grow to four or five feet in height. On rich upland it yields a large amount of good hay. On good bottom land the yield is still larger. Its winter growth is heavier than that of any other grass, except the Italian rye-grass in favorable positions. It is somewhat surprising that this grass is not enumerated in the list of Texas grasses appended, as it is certainly a native of the West. The writer has been informed by others that it stands winter grazing at the South well. He cannot speak

from his own experience, as he has been unable to obtain seed in sufficient quantities to make an experiment on a scale large enough to render it practically reliable.

If his information be correct, so far as present experiments have gone, it certainly deserves to be placed at the head of winter grasses for the South.

In confirmation of this opinion, it may be instructive to quote a few authorities Dr. Muhlenberg, and Mr. Taylor, of Virginia, the author of Arator, consider this as the most valuable of the grasses.

"It possesses the advantage," says Judge Buel in the Farmer's Companion, "of early, late, and quick growth, for which the Orchard grass is esteemed, and is well calculated for a pasture grass. We have measured it in June, and when in blossom, (at the time in which it should be cut for hay,) and found the seed stems four and a half feet long.

"The latter math is nearly equal in weight and superior to the seed crop."

Sinclair says: "It thrives best on a strong tenacious clay, and Muhlenberg prefers for it a clover soil."

Dickerson remarks that "it makes a good hay, but is most beneficial when retained in a state of close feeding."

The British Cyclopædia states that "it affords a greater weight of hay than most grasses. On the Continent, in comparison with common grass, it is found to yield in the proportion of 20 to 2."

Loudon says: "Every animal that eats grass is fond of it, while it makes the best hay and affords the richest pasture. It abounds in the best meadows about Lacock and Chippenham, and has the valuable property of abiding in the same land, while most other grasses are constantly changing."

Mr. Lewis Sanders, of Kentucky, says: "I have been informed by an experienced trainer that the use of hay made of the tall meadow oat-grass, as the fodder fed in training keeps the bowels in a natural condition, dispensing with any use of balls, physic, &c., thereby giving the horse several lengths the advantage of the one weakened by physicking. My own observation and experience in feeding cattle sustain the remarks of 'an experienced trainer,' as to the feeding this species of stock with hay made of the tall meadow oat-grass or orchard grass. Sow the seed on ground well prepared, as it usually is for the reception of timothy or other small seed, fall or spring. As early in the spring as the ground can be prepared is the surest and best time to sow meadow oat-grass or orchard-grass seed. In June of the first year weeds will make their appearance, then, with a keen scythe, mow weeds, grass, and all close to the ground. The next year comes a good crop of seed. As soon as the top seeds are ripe secure it with a cradle or scythe. Immediately after the seed is cut mow closely for hay; then, about the last of August, you have a second crop of hay, yielding more than the first, leaving the best of all pastures for colts and calves."

Mr. George H. Waring, of Habersham county, Georgia, a gentleman in every way reliable, makes an extraordinary statement as to the yield of this grass in hay on a small piece of rich land. He states that the produce of a piece of ground 90 feet by 10, was weighed by him, and the result in dried hay was 210 lbs. This is at the rate of about five tons per acre, which would be an enormous return.

Mr. Gideon Dowse, of Richmond county, states, in the Southern Cultivator, that this grass thrives well near the Richmond Baths, in Richmond county, Georgia. The lands there are naturally poor and very sandy, and would be considered as unfavorable to grass culture as any lands in the Southern States.

On the whole, Southern planters are advised to make careful, judicious, and yet vigorous experiments with the tall meadow oat-grass. The seeds can be obtained from the seedsmen at the North, especially in Philadelphia. The attention of the Southern people was first called to the especial value of this grass in Southern agriculture by Mr. J. R. Stanford, of Clarkesville, Habersham county, Georgia, who has been raising it successfully for a number of years.

19. Randall grass.—The writer has been unable to obtain the seeds of this grass, which is so much valued in parts of Virginia. Experiments made with it by others in this immediate vicinity have not been satisfactory, the hot sun of the past dry summer having been very hurtful to it.

20. Terrel grass or Wild rye.—This native grass obtained the name of Terrel grass from the fact that it was first brought to notice and use by Dr. Terrel, of Sparta, Hancock county, Georgia, a gentleman whose name will be perpetuated in Georgia as the liberal founder of an agricultural professorship in the Georgia University.

The botanical name of this grass is *Elymus*. There are two species of it—one a swamp and the other an upland growth. They differ in the shape of the seeds and the size of the plant, the swamp plant being the taller of the two. The difference in value is not material. This grass is a native in all the cotton States. It is found in Georgia from the sea-coast to the mountains, only, however, in spots in which it has been inaccessible to live stock.

Since it has been made so frequent a subject of remark in the Southern Cultivator, speci-

mens have been sent to the writer from South Carolina, Alabama, Tennessee, Mississippi, Arkansas, and Texas, with inquiries as to whether this was the Terrel grass. In each instance such proved to be the case, showing that it was originally diffused throughout all these States. It will be found fully described in the accompanying list of Texas grasses. The Terrel grass makes an abundant but coarse hay, which is, however, relished by live stock. Its chief value is for winter pasture, for which purpose it is admirably suited. It will be valuable in proportion to the richness of the land. About one bushel of seed should be sowed to the acre. The difficulty of obtaining the seed is an obstacle to its rapid introduction, as it is not in the hands of the seedsmen.

Almost every observant planter can, however, obtain enough of it on his own land to make a commencement. It may be readily known by the long beards of the seed, closely resembling the beards of rye. No planter in any part of the South who can obtain the seeds of this grass need be without a good winter pasture.

The Terrel grass succeeds admirably in woods pasture; this, indeed, is its natural position.

21. English rye grass.—Experiments with this grass have not been satisfactory. It has lived, but yielded no good result, and has been abandoned.

22. Italian rye grass.—This is the most beautiful of all the grasses. Its winter growth on very rich land is enormously great. Nothing can be more beautiful than the deep glossy verdure of this grass, when surrounding nature bears the desolate appearance of mid-winter. It is, however, capricious as to its duration, being sometimes annual and sometimes perennial. It must be recommended rather as an ornament than a utility.

It may be an object near large towns, where manure is abundant, but will scarcely find its place in the rough usages of the plantation.

In consequence of the extraordinary results stated by Colman as being attained in Europe from this grass, special pains were taken in experimenting with it. The first seeds tried were obtained from England, the second from France, and the third direct from Italy.

There was no material difference in the results. The Italian seed was sown last spring; they came up and grew vigorously, but almost entirely perished during the severe drought of the past summer.

It is worthy of notice that a few Lucern seeds came mixed with the grass seeds.

The Lucern is now growing luxuriantly, while the grass has disappeared.

23. English meadow soft grass.—This grass, which grew tolerably well for two years, and which stood winter grazing satisfactorily, was killed by the drought of the last summer.

24. Feather grass—Paris grass—velvet grass.—All popular names of the same grass. Rejected as unworthy of attention.

25. Deer Park grass.—This is a native of Louisiana. It resembles the Terrel grass, to which, on the whole, it is inferior.

26. Meadow vernal grass.—This grass is highly valued in England, as it springs very early and gives a delightful fragrance to the hay of which it forms a part. It has been long known as a border in southern gardens under the name of "vanilla grass," from its peculiar and agreeable odor. It is an evergreen, grows readily, but is diminutive, and has no merit in which it is not exceeded by other grasses.

26. English fox-tail grass.—Rejected as unsuited to a Southern climate.

27. Herds grass.—For certain positions and for certain purposes this is an exceedingly valuable grass. It is suited to moist ground; in fact, it grows almost in running water. It requires a stiff, close, and wet soil. It will render valuable lands otherwise useless. It will grow on a pipe clay soil, provided it be not that kind of pipe clay which is very wet in winter and very dry in summer—it should be moist all the year. This grass is recommended as occupying favorably the wettest part of the plantation, from which it will yield a heavy return of valuable hay—quite as valuable as sheaf oats. It will bear being under water a good portion of the winter without injury to it. It will grow well under a partial shade, as in woodland thinned out.

28. Musquit grass.—The variety of musquit under experiment by the writer has been a soft, woolly grass, green during the winter, but not standing grazing as well as some other winter grasses. It is probably the same with No. 2 in the Texas list.

29. Crab and crowfoot grasses.—The latter of these valuable annuals is peculiar to the sandy lands of the South. The former is a universal product. Until a plantation is stocked with permanent grasses, these should be used for making hay. For this purpose it is not prudent to rely on the after growth from the grain fields. Sufficient ground to afford hay enough for the use of the plantation stock should be manured in the spring; the ground should be deeply ploughed, harrowed, and rolled. If it should happen, as is frequently the case, that weeds precede the grass, the weeds will disappear, and the grass alone will come up. Even this process of getting hay is much less laborious than pulling fodder. Still, it is a labor that should be encountered only until permanent meadows are established, which being once laid down last a lifetime.

30. Rescue grass.—This is an annual, and in every way inferior to common rye, when used for winter grazing.

31. Bermuda grass.—Public opinion seems to have changed very much at the South in regard to this grass. It was at one time regarded with terror by the cotton planters. Now many of them are setting it out on their plantations. It is quite certain that no other grass will, in a hot climate, yield as much good grazing during the spring, summer, and autumn as Bermuda grass. It is, however, objectionable, as it requires to be set out by the roots, and when once fixed in the soil it is very difficult to eradicate. Where plantations are destitute of good pastures, and time and inclination are wanting to put land in sufficient condition to bear other grasses, it would, without question, be good policy to stock the permanent pasture land with Bermuda grass. Care will prevent its entrance into the cotton fields. On sandy lands, in which it is destroyed with comparative ease, it may be questioned whether it would not be judicious to introduce it as part of a regular rotation of crops. Its fertilizing power is certainly very great—perhaps quite as great as that of red clover. It will live on land so poor as to be incapable of supporting other valuable grasses, though its value is in proportion to the fertility of the soil. It seems to be determined that below the mountainous parts of the Southern States, if stock be kept away from Bermuda grass during the summer and autumn, although the ends of the grass may be nipped by frost, that there will be sufficient green grass underneath to feed stock during the winter. This being the case, it must stand unrivalled as a grazing grass in the Southern States, taking into the account the whole year, both summer and winter. On very rich land it grows tall enough to be made into hay, and the hay is of the very best quality. The premium bale of hay at the recent Fair of the Georgia State Agricultural Society was made from Bermuda grass.

To this list of grasses, all of which, with exception of the Randall grass, have been subjects of careful experiment by the writer, he begs to add a list of Texas grasses forwarded to him by Mr. Gideon Lincecum, of Long Point, Texas. The comments of this gentleman on these different grasses cannot but be read with great interest by the Southern planter. There can be no doubt that most of these valuable grasses will thrive in the Southern States generally, if land now worn out be made sufficiently rich to grow them. There is every reason to believe that most of these grasses originally grew throughout these States, and have been destroyed by careless grazing and culture. The Texans should be warned by this result. They have the benefit of our wretched experience. We are now compelled to create; they only to preserve. Of the fourteen varieties described by Mr. Lincecum, the writer has found five now growing in protected places on this farm. The probability is that all of the others once grew here, and have been destroyed in the manner above suggested.

1. Indigenous—perennial.—*Bromus.(?)*—This is our upland wild oats. It is a very sightly grass; flourishes best in good sandy soil; has a pretty fair crop of radical leaves; the seed stem rises three to four feet, having many leaves, and having heads; makes good hay in May. Its perennial roots have visible buds all winter, rises early in spring, and is much sought after by the cattle. It is now rarely found out of the enclosures.

2. Indigenous—biennial.—*Feather grass.*—Common in gullies and protected places, growing quite thick. In these situations it does not rise exceeding six or eight inches, but when properly dealt with, grows quite a heavy crop, three feet high, producing as good hay as needs be, and is ready for the scythe in early May. It comes up during the autumnal rains, and as it remains green through ordinary winters, it affords pretty fair grazing for sheep. It dies out as soon as the seed matures. Would have to be sowed every year, on which account it is objectionable for a hay meadow, but would do well among other grasses for a winter sheep pasture. It cannot stand a frost that would kill wheat or oats.

3. Indigenous—biennial.—*Elymus.*—Smallest wild rye. This species is often found growing with No. 2. They make their appearance together during the fall rains, grow all winter, forming a pretty carpet of grazing grass, for graminivorous animals generally. The habits of these two species of biennials and the odor and quality of the hay they produce, are so much alike that to separate them in the meadow would be useless.

4. Indigenous—biennial.—*Phalaris.*—This is a superior grass for hay. Comes up during the autumnal rains, and its odor, taste, habits, and in its mode of throwing off radical branches, it so much resembles the wheat that it requires considerable familiarity with both, during the winter and spring months, to distinguish one from the other. It matures towards the first of May, producing hay of as good quality as any known species. A few years ago I prepared the ground and sowed two acres of it. It rose three feet to forty inches in height, and was mowed on the 28th of April. It produced a fine lot of hay, and, coming at the time it did, seemed to be more acceptable to my plough horses than anything I had of the fodder kind. I have seen bunches of this grass, in favorable situations, seven feet high, with fifty-four stems bearing heads on the same stock. Its seeds are about the size and very much like the flax seed. Flourishes well on all our good timbered lands, but much the best on our black prairie soil.

5. Indigenous.—*Bromus*—Rescue grass.—Cultivated in Georgia, Alabama, and Mississippi.

Indigenous to Texas, West of the Brazos. Will do to brag about in other Southern States. In Texas it is not very popular. We have many kinds superior to it.

6. Indigenous—perennial—*Stipa—Bearded musquit—Blue musquit.*—This is the far-famed musquit of Texas. It is rapidly spreading itself Eastwardly. I was here twenty-five years ago, when it was remarked to me by several observant Texans that this species of musquit had not yet been found east of the Colorado, but that it was evidently travelling eastwardly. The native Mexicans told me that it had not been many years since its first appearance east of the Guadeloupe river. I did, however, succeed in finding a few plants of it East of the Colorado. It is now found—I saw it myself—as far east as the Trinity river—perhaps still further. It is a valuable winter grass, very closely resembling, during the winter and spring months, the blue grass of the more northern districts. It produces pretty fair hay, where it has not been grazed off during the winter and spring months. It is, however, better adapted for winter pasturage. Hogs do well on it during winter, and in countries where it is abundant they become very fat during summer, feeding on the large crops of grain which it produces. It is greedily devoured by the graminivorous animals generally in the winter season, but towards the first of March, or as soon as the spring sap rises in it, if there is any other grass to be had, they will not eat the musquit, and it is suffered to mature its large crops of seed unmolested every year, which accounts for its rapid increase and its migratory habits. It propagates itself by its radical buds, and by its seed, and one set of roots will occupy the same ground for an indefinite period. My experiment with it is three years old; it is looking very well. I do not let it mature seed. When rightly dealt with this species of musquit produces heavy coats of nutritious food for hogs, cows, horses, and sheep. The sheep, however, should not be permitted to run upon it during summer, as its bearded seeds will work through their wool and into their flesh by the thousand, when it is very troublesome to the wool picker and injurious to the sheep.

With much interest and some care I have been observing, for the purpose of ascertaining them, the habits and use of this reliable species of stipa, during the last twelve years. It flourishes best in the wild state, on level plains of black prairie soil; second, on bottoms to our rivers; but it is seen in its greatest luxuriancy where it has crept into our cow lots and places that have been much trod out by our stock.

From these results my conclusions are, that any of our black prairie lands will produce it in sufficient quantities for a high order of winter pasturage, and hay too, if it is desirable to grow it for that purpose. On the timbered lands and lighter soils it would be best to prepare the ground by a series of cow lots, or any other convenient cheap plan that will change the untutored nature of the land and leave a light sprinkling of manure upon it. Any time from the first of July to the last of October will do to sow it. It grows from two to three feet high, and matures in June.

7. Roots perennial—indigenous.—*Agrostis.*—As a common name, I have called it White Top. I am not certain, but I think it belongs to the genus *Agrostis.* Its roots are perennial, propagating itself by radical buds, and by numerous minute flying seeds. It grows strong, and during the winter season, if left unmolested, will pile up its long, juicy, radical leaves to the height of six or eight inches from the ground. In this state and all other stages of its growth, it is eagerly eaten by swine and all other grass-eating animals. Mowed in the proper season, it produces hay of such extraordinary richness in appearance, and the aroma emanating from a recently cured heap of it is so pleasant, that even a man feels himself invited to taste of it.

A pasture of this grass may be freely grazed through the winter, and it will remain green all the time. It sustains no injury from the severest frosts, and such is the rapidity of its growth that it quickly shoots up its cropped blades, keeping a rich green pasture throughout the cool season. To insure heavy crops, the portion of the meadow that is intended for hay should not be grazed after November. About the first of April it begins to send up its seed stems, which rise thirty to thirty-six inches, and by the first of May it is sufficiently mature for making hay. I have been making observations on the habits and uses of this grass for the last eight years, and find that it flourishes well on all our soils in Texas except dead beds of sand. It is a rare thing now to find a headed-up stem of it outside of the enclosures.

8. Indigenous—perennial.—*Tripsacum.*—Very common on all our black prairies, and in bottom lands. It grows very strong in Texas. If we did not grub it up every year it would overrun our black prairie farms in a few seasons. It produces good cow-fodder. Horses do not like it unless mowed while quite young. A meadow properly set with this grass and the next described species, No. 9, will not require renewing in a century.

I have a meadow of thirty-five acres on black prairie soil, which consists principally of these two grasses; and being densely jammed on the ground, the gamma grass is not near so rough if mowed in June or September, at which season it is nice and tender, producing a quality of hay to which horses do not object, but eat it freely and thrive well on it. It produces immense quantities—I mean the mixed meadow—and it is so easily procured, that we have given up fodder pulling altogether. Our horses eat it freely winter and summer.

9. Big Musquit—Wavy Musquit.—This grass, higher up the country and Westwardly, is found occupying, almost to the exclusion of other varieties, large tracts of valley prairie land, and is considered a very valuable grass for constant grazing. My meadow consists principally of this and the gamma grass, and I notice that they are increasing and gradually crowding out inferior species. The land which I have enclosed for meadow is black prairie; has never been ploughed; it is now ten years since it has been enclosed, and it is annually improving in the quantity and quality of its hay. I think it quite probable that I possess a lifetime meadow. I do not suffer it to be burnt off nor grazed on. Of seasonable years it will bear being twice mowed. The radical leaves of the big Musquit are twelve to eighteen inches long, tapering the whole length, with withered points, seed stem small, prostrate, two to three feet long, seeds small and not very numerous. Blooms in September.

10. Roots perennial—indigenous.—*Buchloa.*—*Hogwallow Musquit.*—I would give you the botanic character of all the specimens I send you, but that is a matter in regard of the grasses of Texas which as yet has not been satisfactorily settled. But to return to the Hogwallow Musquit. Previously to the settling of Texas this sweet little carpet grass could obtain footing only in the hogwallows. Hence its name. But as the other species of grasses are eaten out, we find it rapidly spreading itself; first along the track of old roads, tramped out places about the gates and lots of farms. Already there are whole acres of frequent occurrence completely carpeted with it. It does not flourish in shaded places, but delights in sunshine, and is destined soon to be our only outside pasture. It does not rise above three to six inches, and is peculiarly adapted to the taste and the health of the various types of the genus *Ovis.* All other grass-eating animals devour it with great gusto, and do well on it. Wherever it gets a footing, other grasses and weeds are forced to give way to it. Like the Bermuda grass, which in its habits and appearance it very much resembles, it spreads its luscious green carpet on the ground it selects, to the utter destruction of all other grasses and weeds in its way. Blooms in May and June, and of seasonable years it is green through the summer, and will spring up in the winter if there comes a warm spell of ten or twelve days' duration.

11. Roots perennial—indigenous.—*Setaria.*—Delights in moist lands, where it grows finely; but will do well on almost any of our soils in ordinary seasons. Rises thirty to forty inches, having, when it is not too thickly set, thirty to sixty heads to one root. It is a rich, juicy, leafy grass, much sought after by the cattle and horses; so much so that it is now rarely found outside of the enclosures. It matures and is ready for the scythe in June.

Owing to the rains which occurred in August, it has headed twice and will mature two crops this year. Needs further investigation.

12. Roots perennial—indigenous.—*Paspalum.*—This is a soft, succulent grass. Does not cure readily, and therefore not suitable for hay. It is, however, a rich grazing grass, and will, with small labor in clearing out the underbrush, produce the most profitable kind of summer pasture. Blooms in June; and this year, with our two spring seasons, it has bloomed again in September.

13. Roots perennial—indigenous.—*Elymus.*—This I suppose to be the Terrel grass of Georgia. In days gone by this was an abundant growth in the dry bottom lands of Texas. In some portions of the country it is pretty plenty yet. I have seen the people of Austin, twelve years ago, hauling the hay they had made from it in June. They told me that it was so plenty, and so easily procured, that they could cut and haul it fifteen miles at less expense, and that it was better than any other kind of roughness they could get in the country. I am not certain that we have not a biennial species of the large wild rye. I will take pains to decide this matter next year. The specimens I send you are the perennials. This species flourishes finely on our uplands, either prairie or timbered soils. In good soil, when not too thick, it grows in very large bunches, with heavy heads. I have seen it four feet high, and have counted as many as seventy-four heads to the same root. Recently, however, this species has been forced to steal away among the weeds, in the ditches and gullies, in the fields and inside corners of the fences, for protection from its devouring pursuers. I am of the opinion that it will not be long before it will find friends in Texas, where it will be found to be very capable of remunerating the frugal husbandman for any pains he may take with it. Blooms in June.

14. Roots perennial—indigenous.—*Uniola.*—This is the oft-mentioned wild oats, so favorably spoken by the Texan traveller. In portions of the State, where there are but few cattle, it is, indeed, a growing wonder. It delights in rich, dry bottom land, where there is but little undergrowth; will flourish well on any good soil. I have travelled over fields of it, in the Brazos low grounds, twenty miles long, and I don't know how wide, growing so thick over the ground that our horses could, and did, fill themselves before they had straightened out their stake ropes. Of all the grass families, in my estimation, this is the most beautiful; when it is fully headed up it dazzles the eyes to look up to its heavy waving panicles. I predict that at some future day it will be highly esteemed and profitably cultivated. It cannot be overlooked, surely, with all its attractive beauty and its rich, nutritious properties.

The prudent agriculturist will not, as has been the case with many other good species of grasses, suffer this lovely one to become extinct.

When not too thick on the ground it sends up forty to sixty heads; seed stems, from the same root, rise from three to four feet. Blooms in June. Its leaves remain green on the stem through the winter, looking like the leaves of small reeds. Its seed, also, remains on the panicle until Christmas. As most of the grasses I send you are found in Texas as far North as latitude thirty-third degree, I think it likely that some of them, if they are not already there, would do well in Georgia. In 1811 I saw the bearded musquit (*Stipa*) in Putnam county, Georgia.

G. LINCECUM.

IV.—LAYING DOWN MEADOW AND PASTURE LAND TO GRASS.

Some plain and simple directions as to these points will conclude this Essay. Northern readers who have been accustomed all their lives to grass culture may consider these directions very unnecessary. But at the South, to the majority of readers, the subject is a new one. The cotton planter has heretofore considered it to be his especial mission to "kill grass." He forgets that while it is a part of his business to kill hogs, sheep, and cattle at the proper time, he yet raises pigs, lambs, and calves for a future supply of food for himself and family; and thus while at the proper time he "kills grass," it is equally necessary to raise young grass in other places to afford future food, directly and indirectly, to his cotton and grain crops, and that in no other way than by grass culture can the fertility of his lands be kept up, except at an expense which is ruinous.

For low ground meadow the best bottom land on the plantation should be selected. If it be very wet, and cannot be drained without too great an expense, herds grass alone should be sowed at the rate of a half bushel to the acre. If it be well-drained bottom land, four quarts red clover, the same of white clover, a peck of herds grass and a peck of timothy per acre should be sowed. The ground should have been thoroughly ploughed and harrowed until all clods are broken down, and the seed should then be lightly bruised or rolled. For upland meadow, Lucerne alone is by all means to be selected. Directions for its cultivation have been given above.

For summer pastures on open land, reliance must be had chiefly on the natural grasses, if the planter is afraid of Bermuda grass. No pasture, however, need be better than crab grass, after the grain crops are removed. The growth of these grasses is a peculiar and inestimable advantage of the Southern States.

For spring, autumn, and winter pastures, on upland, sow a mixture of blue meadow oat, orchard, terrel grass, with red and white clover. For pastures on low land add to the above herds grass; if the ground be very wet, sow herds grass and white clover alone. These will actually dry up wet places.

The chief reliance at the South should, however, be on wood and pastures. All the grasses mentioned above will grow in the shade of trees. The use of woodland for this purpose answers a double end. Land now idle is put to a valuable use, and all the open land of the plantation by the additional stock raised can be kept in a state of improvement.

The preparation of woodland for pastures is as follows: Take out rail timber enough to fence it, grub the land carefully, cut out useless trees, leave especially the most bearing trees, as in a thinned and trampled pasture they will bear fruit almost every year, and thus greatly diminish the cost of hog raising. Burn the logs and brush in as small heaps as possible and scatter the ashes. Wherever a log or brush heap has been burned, the grass sown will take hold with vigor.

As it is impossible to make woodland fine with the plough, great care must be taken in covering grass seeds. Wherever a clod is turned over on seeds they do not vegetate. If it be possible to sow during a snow or drizzling rain, no covering of the seeds is necessary. A short roller is perhaps the best instrument to cover with. If oxen be used, or a very gentle mule, a short roller can be managed in thinned woods. The ground for wood pasture should be ploughed as well as the nature of the case will admit.

No stock of any kind should be allowed to go on the pasture after it is sown until the grass has once gone to seed. This will fill the ground with seeds for future use. If the pasture be designed for winter use no stock should go on it during the summer. If it be designed for summer use no stock should go on it in the winter. The same pasture cannot be used all the year round. Stock should be taken from the winter pastures in very wet weather unless it be sheep. They should not be grazed at any time too severely; too close grazing will destroy the grass; it will produce this effect in any climate. The planter should treat his winter grass pastures as he has been in the habit of treating his rye and barley lots for winter grazing.

A woodland pasture, well stocked with good grasses, will pay the interest annually on more than fifty dollars an acre, while at the same time the valuable timber is preserved for plantation use. No planter who has ever tried such a pasture would part with it for fifty dollars an acre. If it cost him ten dollars per acre to prepare the ground, buy and put in the seeds, &c., how great is his gain!

There must be a revolution in Southern agriculture. The process of exhaustion must be stopped, or it will stop itself. The improvement of the soil must be considered. This is the point at which to begin. The commercial manures answer a special and temporary purpose. The only permanent reliance for valuable improvement of the soil is by means of the manure of the domestic animals. These can be raised to profit only with the aid of the artificial grasses. Our cultivated lands are too much exhausted to produce valuable grasses in their present state. Our woodlands, with a dressing of the ashes produced in thinning them out, will produce these grasses. Thus a sufficient quantity of manure can be obtained to begin a system of improvement which may ultimately comprise the whole plantation.

It is firmly believed that the now idle woodlands of the South can be put in a situation to raise sheep enough to allow a sale of wool equal in value to the present cotton crop, and that this result can be obtained with a positive increase of the cotton crop from the manure of the sheep.

The opinions positively expressed in this Essay are not speculations. They are not mere theories. They are based, so far as is possible, on the practical observations and experiments of a man who has been grieved to witness the gradual impoverishment of the fair domain of the South, who has pondered the subject long and carefully, and who has been brought to the conclusion that our hope of improvement is to be based upon the adoption of a mixed husbandry, of which the cultivation of the artificial grasses is an essential part, and which contemplates by the aid of these grasses the rearing of sufficient live stock to manure annually all the land in cultivation.

CATTLE DISEASE, OR PLEURO-PNEUMONIA.

BY G. EMERSON, M. D., AND A. L. ELWYN, M. D., PHILADELPHIA.

SIR: In pursuance of instructions received from you, dated the 19th of June, we visited the State of Massachusetts for the purpose of investigating the "Cattle Disease," or Pleuro-pneumonia, which, during the last year and up to this time, has existed there, and from which much loss has been sustained by some farmers, and a general damage inflicted upon the rural interests throughout the New England States.

The alarm occasioned by the recent spreading of this cattle disease in Massachusetts has extended far and wide over our country, a proof of which was given by the number of commissions sent from various States, by public authority, to investigate this epizootic. Beside those from Maine and other parts of New England, New York, New Jersey, Pennsylvania, Ohio, and Indiana were all represented by deputations with the same object. Governor Banks and other State authorities, with Charles L. Flint, Secretary of the State Board of Agriculture, all contributed every facility we could desire to further our objects, and we should be ungrateful if we did not acknowledge our obligations to them for their assistance in procuring information.

A knowledge of the existence of a similar disease among cattle in some parts of New Jersey and Eastern Pennsylvania—three hundred and four hundred miles to the Southwest—had not reached Massachusetts previous to the time of our visit, and might probably have exerted some influence in modifying legislation upon the subject. But in New Jersey and Eastern Pennsylvania the presence of the cattle disease was for a long time suppressed, nor did it obtain publicity until inquiries were set on foot by the Philadelphia Society for Promoting Agriculture, at its meeting held in the first week of June. This society then appointed us a committee of investigation, and, at the instance of the Hon. Thomas G. Clemson, Chief of the Agricultural Division, we were subsequently charged with instructions from your Bureau of the General Government to proceed to Massachusetts to investigate the cattle disease, and to report to you upon the subject. The very short time allotted for this purpose must be an apology for omissions and imperfections naturally to be expected.

In Massachusetts, where the agricultural interests are based upon its neat stock, the spread among them of a fatal disease, resembling that which for many years past has been devas-

tating the herds of Europe, naturally produced much public excitement and alarm. The legislature, during its regular session, took the subject into serious consideration, and displayed, in their vigorous action, the tone which has animated most of the European governments in their efforts to check the plague or lessen its violence.

Viewing the disease as one brought from a foreign country, and propagated by contagion alone, the Legislature, at its regular session, passed, on the 4th of April, an act providing for the appointment of three commissioners, who were required to take measures for the *extirpation of the disease.* They were authorized and required to visit, without delay, the several places in the Commonwealth where the disease was known or supposed to exist, and empowered to cause all cattle which had been diseased, or had belonged to diseased herds, to be forthwith killed and buried, and the premises where they were kept cleansed and purified; to appraise, in their discretion, the value of the cattle killed which were apparently well, and certify to the governor and council the allowances made to the owners, and give such lawful orders and directions as, in their judgment, the public necessity might require.

The commissioners promptly entered upon their duties, and, from the sickness found in various herds and the number of cattle they had occasion to slaughter, the appropriation of $10,000, placed at their disposal by the legislature, was soon exhausted, with a like amount furnished by contributions from the State Agricultural Society and liberal public-spirited individuals. But it was soon found that the disease had spread itself over a larger extent of territory than it was at first supposed to occupy. More appropriations were required, and the governor summoned an extra session of the Legislature, on the meeting of which a large amount of valuable information relative to the nature and progress of the disease was collected and immediately published.

The commissioners reported that, in compliance with the summary instructions given them, they had slaughtered over eight hundred head of cattle found diseased or suspected. They were released, at the extra session, from the necessity of slaughtering all diseased stock, and, at their option, empowered to carry out a system of isolation. The governor, in his message to the extra session, viewed the disease as one purely contagious, not a disaster affecting Massachusetts or New England alone, but a contagion which, if allowed to spread without effort to extirpate or restrain it, must ultimately ravage the whole country. Upon the basis furnished by the Census of 1850, he estimates the present property in cattle throughout the Union at no less than six hundred and forty millions of dollars, an interest only second in importance to that of Indian corn. "But these figures," he observes, "very imperfectly represent the interest of the American people in their gigantic industrial product. How far it enters into the employment of the great majority of persons—how many millions are dependent upon it for the luxuries and necessities of life—to what extent it contributes, indirectly, to public health and enjoyment, and how large a part it forms of the sound and reliable business of the country, are considerations which naturally occur to the mind of every intelligent person."

"If," he continues, "we could confine the ravages of the fatal distemper, so unfortunately deposited on our shores, to our own State, it would still be of sufficient importance to demand the earnest attention of the people; but unless extirpated on the instant when it appears, it cannot be so confined. If it spread over our own territory, it must ravage other States; and it becomes a duty of the highest character—one which we owe alike to ourselves, to the honor of Massachusetts, and to the people of the whole country—to make every available and possible effort to restrain its ravages, if extirpation is impossible.

"Admitting, if need be, that it is doubtful whether it partakes more of the character of a contagion or an epidemic—admitting that it may not be in our power to prevent its spreading through the country—nevertheless every citizen of Massachusetts should have it in his power to say that every proper effort had been made by the State to produce that result. I am constrained to express the opinion that all has not yet been done which may be wisely if not successfully performed; and this fact I offer to you as a chief reason for this extraordinary convocation. This would seem to be a measure which the natural comity existing between friendly States would absolutely demand. Such a measure would for a brief period—not necessarily a long one—interfere with the freedom of trade, but it is such an interference as the continued existence or the trade in cattle itself requires. A line may easily be established, beyond which no cattle shall be passed without sufficient official assurances that they do not carry contagion with them."

The governor, in his message, recommends the adoption of public regulations to prohibit, so far as it can wisely and properly be done, the exportation from Massachusetts to neighboring States of cattle in which the seeds of disease may possibly exist. In all this vigorous action of the public authorities of Massachusetts we recognize the most laudable efforts to arrest the disease, and, if possible, prevent its extension to other States, at whatever sacrifice.

Admitting that the first alarm may have led to exaggeration of the evil at hand, and that the prevailing impression in regard to the mode in which the disease was solely propagated

was an open question, still the motives which inspired the public authorities of Massachusetts do them much honor and merit the commendation of sister States.

The legislature of the neighboring State of Connecticut has since taken up the subject, and recently passed stringent laws involving heavy fines and imprisonment where persons are found transporting cattle from one part of the State to another without proper authority. It remains to be seen, and time will soon show, what results will be gained from measures so promptly taken in New England to arrest the progress of this cattle plague. Meanwhile a similar disease has manifested its presence in New Jersey and in the neighborhood of Philadelphia, where it has caused much destruction in many dairy herds during the past winter and spring, and up to this time. Rumors of its appearance in other parts of the country are given by the press.

Having thus brought to your notice the action of legislative bodies, so far as they have yet proceeded in this country, in regard to the visitation of this new disease in the United States among cattle—one which threatens so much our agricultural interests—we offer the following statement of what we have gathered relative to its history, causes, nature, means of prevention, and remedial treatment:

HISTORY OF THE FIRST RECOGNITION AND DIFFUSION OF PLEURO-PNEUMONIA.

The French government, with that zeal which it always shows for the promotion of its public interests, some years since appointed a scientific commission for the investigation of epizöotic pleuro-pneumonia in cattle. From the report of this commission it would appear that this disease was an endemic epizöotic, confined in former times to various isolated regions in the mountains of Piedmont, Switzerland, Franche Compté, Dauphiné, the Vosges, the Pyrenées and Auvergne. With the exception of these places, its inroads upon the agricultural interests were so limited as not seriously to affect the public weal until the year 1789. Whether the French commission may not have gone further back in dating the first appearance of this disease in Germany, Holland, and perhaps other countries, is a question of some interest, which, however, we have not time to investigate.

This formidable disease of neat cattle has of late years prevailed simultaneously over large tracts of Europe and other parts of the Old World, exhibiting everywhere the same leading characteristics. It would, therefore, appear to result from the operation of some general cause, and hence belong to the class of diseases denominated epizöotic. By its wide-spread ravages in many parts of Europe it has ruined many dairymen, breeders, and stock-owners, and exerted a great influence upon the beef-market.

So far as we have carried our investigations we have not found the prevalence of the cattle disease on this side of the Atlantic affected by the character of the country, whether upland or valley, dry or marshy, in proximity to the sea, or distant from it.

In Massachusetts the first cases known were on high land, about seven miles west of Boston, and the most general spread was after a leap of sixty miles to the west, also in a hilly region. We have, however, no idea that it was attracted in this movement by the character of the locality. Nothing unusual has transpired in the conditions of the weather, except the prevalence of drought during the spring months of the present year in New England. But in New Jersey and eastern Pennsylvania the weather has been seasonable, and the winter past of the average temperature.

That the cattle disease has prevailed in New Jersey and in Pennsylvania, in the proximity of Philadelphia, during the past winter and spring, and there prevails at the present time, is certainly known. In the absence of any proof of its introduction here from abroad, we are inclined to ascribe its presence to epizöotic agency. Be this as it may, there is good reason to believe that here, as in Massachusetts, contagion has been active in spreading the disease. Wherever we have met with it, the symptoms and post mortem appearances correspond most strikingly with those described by continental and English authorities.

Whether spreading by contagion or by epizöotic agency, pleuro-pneumonia is usually found to select herds exposed to some influence calculated to impair their health, whilst it spares those where everything contributed to maintain full vigor.

Epidemic and epizöotics teach us, at great immediate cost, the importance of attending to the laws of health, the visitations of which are so little regarded when no trials are at hand. A family, though suffering from long exposure to unhealthy conditions, may exhibit so little apparent indisposition as to convey the impression that they enjoy good health. So may the owner of a herd of cattle, or of swine, or stock of any kind, suffer these to exist under circumstances calculated to impair their health almost imperceptibly, and render them fit subjects for any disease which may be introduced, either through atmospheric agencies or contagion. Plagues and murrains, though somewhat formidable, yet are far less so than in olden times, when they so often swept off man and beast with the besom of destruction. This comparative immunity is, doubtless, less owing to diminished power of the malign influences operating as exciting causes than to the adoption of measures calculated

to disarm them. For the protection of man the circumvallating walls of cities have been levelled, streets widened, courts opened, dwellings built larger, with means of good ventilation, and thorough drainage established. At the same time the animals intrusted to his care have been better protected. But there is still much room left for further hygienic improvement.

Predisposing and exciting causes.—Some change in the constitution of the atmosphere, the presence of some new specific agent, seems essential to the production or propagation of an epidemic or epizöotic disease. The small-pox and measles, among the human species, can only have a general diffusion at certain times, when the atmospheric influences favoring such diffusion prevail. With respect to the disorder now prevalent among cattle, these have always been subjected, in some places, to bad keeping, and other local causes predisposing them to disease. But such local causes have never before produced, in this country, the general prevalence of a disease with the peculiar characteristics of pleuro-pneumonia. For this the presence of a specific atmospheric agent was essentially necessary. Although bad keeping will not alone produce the specific disease known as pleuro-pneumonia, it undoubtedly predisposes animals to its attacks, and greatly increases its severity when the infection or atmospheric poison presents itself as the exciting cause. So far as our investigations have extended, they authorize us to assert that in cases where much mortality has occurred among cattle, in New England or elsewhere, these have always been previously subjected to unfavorable conditions in their keeping; the most common being want of proper ventilation and cleanliness in stables or yards, with food of bad quality, or insufficient in quantity. Cattle, when closely pent up, must have the air about them very quickly vitiated, and a diseased condition will ensue, which, though not very apparent at first, will secretly but surely tend to produce an unfavorable change in their constitution. When to this exposure to vitiated air the effluvia emanating from unremoved excretions is added, the health of the stock is still more seriously jeopardized. Under such circumstances, diseases may originate, which, in weakened constitutions, soon terminate in death or in lingering sickness incident to poisoning of the blood, from the effects of which many will never recover.

It is a common practice in the New England States to allow the droppings and litter of cattle to fall into a cellar below them, where, during many months, it accumulates in great quantities. These manure cellars are often closed on three sides, with but partial opportunities for the escape of the foul emanations from the reeking mass, more or less of the effluvia from which must rise into the barn above. This cannot fail to add greatly to the impurity of the air, already more or less vitiated by repeated breathings of the confined animals. Stock thus situated live in dwellings immediately over cess-pools—an express violation of the laws of health. A common belief prevails among feeders and dairymen that cattle give most milk and take on fat better when kept warm; and this is doubtless true as a principle. But the attempt to carry it out is fraught with most serious consequences where proper ventilation is not secured; and many ignorant dairymen, in shutting out the cold air, shut in the foul air and effluvia, which finally ends in desolating their herds, or at best in creating a sickly stock. That cattle placed under such conditions should become diseased is a natural result. That such disease, under aggravated circumstances, may become infectious, or capable of communication to other cattle, cannot be doubted. That a herd placed under such conditions should invite or favor the diffusion of infection from diseased stock introduced into it, appears to be too well attested by what we have had opportunities of observing at home and abroad. The history of Mr. Chennery's stock, from which infection appears to have been spread to many parts of Massachusetts, has had the most extensive publicity. The history of other herds in our own vicinity is of the same character. A stock placed under circumstances calculated to undermine its health receives one or more sickly cattle, and disease soon spreads through the herd. The contagious element has in such case found ready access to enfeebled constitutions; but there are other cases where the new-comers may be the first to become sick, and yet have been free from infectious disease when introduced into the new herd. A healthy animal, which has long enjoyed the privileges of the open air, when suddenly shut up closely with other animals, will often be the first to get sick. Under such circumstances, the animals previously confined had become *gradually* accustomed to their unfavorable condition, the sudden operation of which upon the new-comer was more than it could stand. Direct experiments upon this subject, of a highly interesting character, are reported in the "American Farmers' and Planters' Encyclopedia of Agriculture," (last edition,) under the head of *Ventilation of animals.*

It is a characteristic of all epidemic and epizöotic diseases that their greatest ravages are committed at the first outbreak, after which their virulence or malignity abates, and they finally die out; but in many cases the atmospheric constitution on which they depend lurks in countries for years, during which revivals will appear whenever a combination of the predisposing and exciting causes present themselves.

The physiological constitution of cattle, and particularly of cows, creates a great demand for pure atmospheric air, to enable them to perform their active functions of nutrition and secretion to most advantage. Whatever circumstances tend to cut off this free supply of fresh air, or vitiate its quality, serve likewise to impair their health. This undermining of their constitutions may proceed so insidiously as to escape common observation until the more mischievous effects develop themselves.

Among the predisposing causes, everything may, as we have before said, be included which tends to impair the strength and health of animals. Where these are allowed to run out in the open air, bad pasturage, malaria from stagnant water in ponds and ditches, and bad weather, may tend to lessen the energies of the system, and lay them open to attacks when the exciting cause presents itself. In some stables where cattle have been long confined in vitiated air, we have seen the evidences of ill health indicated in the various forms of tabes, consumption, typhus, and scrofula—the last shown by the enlarged joints of the calves.

Young animals, fat cattle and males, appear the least predisposed to pleuro-pneumonia, and, as we have before said, milch cows the most so. These are not liable to the disease during gestation; but soon after calving they appear to be particularly subject to take the disease. When cows are attacked before calving they are apt to abort, in which case, if the calf comes alive, it seldom survives long.

From an interesting paper published by John Barlow, esq., V. S., Edinburgh, we learn some important facts relative to disease of the respiratory organs of the cow, and also of the kind of treatment she too often receives in Edinburgh and elsewhere.

There is, he says, a kind of chronic bronchitis of general occurrence among cows, particularly those kept in town. "Go into the Edinburgh byres, for instance, and you immediately hear many of the cattle cough. On remarking this, you are told with the utmost unconcern that it is nothing unusual. The dairy-keeper thinks 'nothing of that;' because, says he, 'it seems quite natural, and we do know that a cow which does not cough is becoming a phenomenon. But I have remarked that when cattle first come from the country into our byres they do not cough. The cough comes quite soon enough, however, and is due to the same causes which produce sore throat and catarrh in young newly-stabled horses, and is so common—I might almost say universal—that people affect to believe it natural. But is it natural to keep cows in byres so low as to prevent our standing upright? Is it natural to keep them in a temperature so intolerably hot as to maintain the pulse and respiration at something like double the standard number? Is it natural that these low, hot byres should often be so dark and filthy? Is it natural that their walls, floor, and roof should be saturated with an everlasting damp, afforded by condensed vapor, of breath, perspiration, dung, and urine? No wonder cattle cough! No wonder that pleuro-pneumonia occurring among such cattle is almost always fatal! We should always care for a cough in man or beast; it is at all times a sign of irritation. There is much deservedly said against the sadly uncomfortable dwellings of our working classes; too many men, women and children live in dark, ill-ventilated rooms. Some time ago we sent the swine out of this city to country quarters. This was done, no doubt, for their good, and for the benefit of our health. Some future philanthropist may possibly take pity on the animal that gives us flesh to eat and milk to drink; for I can show you byres in Edinburgh offensive as any banished pig-sty, where cattle tied by the neck in the same place for week after week and month after month never draw one single breath of pure air, and are even more closely crowded than the sickly tenantry of our Cowgate and Canongate houses. I am quite aware that cattle require to be kept moderately warm in order to yield large quantities of milk; but I know, too, that there is a possibility of combining the needful warmth with good air, cleanliness, and light."—(Transactions of the Agricultural Society of Scotland, Volume for 1853–1855.)

Symptoms.—The first symptoms of pleuro-pneumonia seldom attract much attention, and the disease commonly steals on without manifesting any great violence. The animal appears dejected, and when in the field separates itself from its fellows, often getting behind a wall, hedge, or other shelter, to keep out of the wind. As the disease progresses it becomes uneasy, loses its appetite, and stops chewing the cud. The eyes appear dull, the head is lowered, the nose stuck forward, the nostrils expanded, and the horns and skin are warmer than common.

With failure of the appetite for food thirst may continue. The urine is generally scanty and high-colored. In cows, the milk falls off either gradually or altogether. It is seldom that the first progress of the disease attracts much notice until the animal stops eating. In some cases, however, it will continue to eat until its blood has become greatly impoverished and poisoned. At this advanced stage the skin sticks to the ribs, the hair loses its sleekness and becomes rough or stary; tenderness is observed when the hand is passed along the spine or pressed between the ribs. The pulsations of the heart and arteries, which in the healthy cow or ox is from 35 to 45 per minute, after three or four days' sickness will increase

to 70 or 80 per minute. At first it appears large and full under the finger, but in the more advanced stages of the disease it becomes smaller and quicker.

The breathing soon becomes heavy or laborious, and quickens as the inflammation increases. The animal in severe cases generally plant their fore legs wide apart, and arch their backs. After three or four days, and sometimes even *sooner*, the active fever of the first stage subsides, debility and prostration ensue, and the passive second stage of low typhus fever sets in, when the heat of the horns and surface of the body falls below the natural temperature.

Cough, although frequently accompanying pleuro-pneumonia, is by no means a constant symptom—being generally absent, or short and grunty, so long as the disease is confined to the substance of the lungs. When, however, the pleura or lining membrane of the windpipe or the bronchial tubes become inflamed, loud and harsh cough is a never-failing symptom. "So active," says Mr. Dunn, of Edinburgh, "is the sympathy between the different parts of the pulmonary apparatus, that inflammation or disease can scarcely exist in any one of its structures without spreading and involving the whole to a greater or less degree." Hence great modifications are observed in the lesions found in the various structures; when the pleura becomes greatly inflamed the nostrils will be much dilated and the breathing hurried and laborious; the inspirations shorter than the expirations. Pressure between the ribs and along the spine causes the animal to wince.

More or less bronchitis or inflammation of the lining membrane of the air-tubes into which the windpipe divides itself exists. This is indicated by frequent cough, at first dry, and afterwards accompanied by a wheezing, rattling sound, occasioned by the air having to pass through the numerous air-tubes obstructed by mucus. During the first stage of the disease a scanty discharge from the nose is observed, of a mucous and mattery appearance. This afterwards increases. Serum and mucus are thrown out, by which the air-tubes become entirely plugged up, suspending the passage of air through the lung or lungs diseased, the blood accumulated in which becomes black for want of oxygenation. In this condition the blood operates upon the system as a narcotic or extremely depressing agent.

Duration.—When the disease ends fatally, death generally takes place from the seventh to the tenth day. Where recoveries may be expected, an amendment is observed about the fifth or sixth day, the pulse becoming less frequent and full, the temperature of the horns and mouth natural, with an equalization of the surface heat, and less hurried breathing. In cases where the inflammation has assumed the subacute form, the duration of the disease is very indefinite. A fortnight, three weeks, or longer, may elapse before any favorable symptoms present themselves.

A chronic cough, occasioned by the increased sensitiveness left in the surface of the air-tubes, may follow recovery. Although a source of inconvenience and suspicion, it does not materially interfere with the health of the animal, which, however, may be subject to a relapse of inflammation, if exposed to exciting causes.

It has been remarked by persons who have given the closest attention to the diseases of cattle that inflammatory affections do not run their course in these so rapidly as in the horse, and are always liable to assume a subacute or chronic character. Catarrhal disease and running at the nose are rarely met with in cattle. Both lungs are seldom equally affected, but the right most frequently, which has been ascribed to the larger size of this lung—admitting of a greater circulation of the blood and air, which tends to develop and support inflammation.

Chances of recovery.—"Where," says Mr. Dunn, "the symptoms of pleuro-pneumonia are very acute, and the inflammation violent and rapid in its progress, a large number of cases will recover; but, on the other hand, when the disease appears to assume a milder form; when the inflammation arises less suddenly and severely, and is more protracted in its course, and when the general fever and local disturbance are less—in all such cases our prognosis will be less favorable and the disease more fatal."

"Cases of pleuro-pneumonia which assume the distinct forms either of pneumonia, pleurisy, or bronchitis, will generally terminate favorably, while those characterized by prostration of strength and typhoid fever will be much more difficult of treatment, and often terminate fatally."

Terminations.—Pleuro-pneumonia terminates in congestion, effusion of serum into the cavities of the chest, including the pericardium, adhesion of the lungs to the sides and midriff, mortification, suppuration, and hepatization. In congestion, the air-cells of one or both lungs are filled up with blood and serum and exhibit a red and gorged appearance. Sometimes one lung will be found so much enlarged as to weigh four or five times more than the other. When serum is poured from the surfaces of the pleura into the cavities of the chest, this may be followed by some return of the appetite and general improved appearance of the animal, which frequently lulls suspicion. This serum may be more or less clear or blood-stained, the latter being indicative of a typhus form of disease. The same observation will apply to the serous deposition which takes place in the pericardium.

Suppuration is not a very common termination of inflammation in the lungs of cattle affected with pleuro-pneumonia, and mortification seldom progresses far before the animal perishes.

Cases of pleuro-pneumonia not unfrequently assume the chronic form of *phthisis-pulmonalis*, while others terminate more rapidly in what may be called a "galloping consumption."

Auscultation and Percussion.—For ascertaining the existence and tracing the progress of this disease, sounding the chest by the ear is of the most important service. When the lungs first become inflamed, the ear applied upon the chest of the animal may detect the part or parts diseased from the feebleness or peculiar sound of the murmur of the air circulating through the lungs. In health this sound may be called low and rustling. As the disease advances it becomes duller, and at last ceases to be heard at all. Striking the fingers over the ribs is called *percussion*, and in the part where the disease exists produces a dull sound. Where serous effusion has taken place, no sound of respiration can be detected below the level of the watery deposit, and percussion yields a uniformly dull sound. Above the water the sound may be clear and loud. The hand placed on the chest over the region of the heart does not feel plainly the stroke of this organ, the impulse of which seems spread over a larger space than usual. The respiratory murmur is, of course, suspended wherever congestion or hepatization exist. In taking the sounds of the chest a handkerchief may be thrown over the animal, and the ear applied directly to its side. It is necessary to take into consideration the age of the animal, as in the young the respiratory murmur is much stronger than in the old. In very fat animals the sounds will be duller than in the more lean, and they will also differ according to the parts of the chest to which the ear is applied. In cattle the respiratory murmurs and crepitating noise of the air passing through the lungs are heard more distinctly than in most other animals. In the first stages of pleuro-pneumonia the rustling murmur seems louder than usual, being accompanied by a low, crackling noise, owing to mucus or serum deposited in the air-tubes. As the disease progresses, the air-cells are more choked up, and this crackling noise becomes duller, until it finally ceases to be heard. Even in the same lung the sounds indicating different stages of the disease may be perceived. In the upper part there may be the crackling, crepitating noise; lower down, the dull, masked, and rumbling sound of bronchial respiration; and below this, the inflammation having run its course, and all circulation of the air and blood ceased, the lung has become hepatized, so that no sounds can be heard.

In percussion, first strike on one side and then on the corresponding part of the other side, comparing the sounds of the two places. Striking with the knuckles or ends of the fingers upon the sides of a healthy animal gives a sound hollow and clear; but if inflammation is present, the sound is obscure in proportion to the severity of the disease.

Post mortem appearances.—In the same animal the lungs on inspection frequently exhibit all the different conditions of the disease, such as hepatization, effusion of lymph and serum, &c. In some cases little else than engorgement is met with. If the animal has died in the first stage of the disease, one or both lungs will be found congested, black and easily broken up, and, when cut into, a bloody and frothy mucus will flow from them. In protracted cases there is more or less hepatization and blocking up of the air passages with fibrous matter with diffused pus. The lung, when cut into, exhibits a mottled or marbled appearance, is more or less easily torn, and so heavy as to sink in water. Hepatization, or the livery condition, is a very common termination. Here the spongy appearance of the lungs in their natural state has been changed into a solidified mass gorged with black blood, and, when cut into, present mottled or marbled surfaces. Portions of this solidified lung are occasionally found surrounded with a coat of fibrous membrane. Sometimes yellow or brownish yellow masses are found encysted, filled with granular matter of a cheesy appearance. A most universal appearance is that of the extensive and firm adhesions found existing between the lungs and ribs and diaphragm. The heart is sometimes flabby, and its cavities usually filled with dark blood. The bronchial glands are sometimes found in a state of suppuration. In some cases the liver is more or less disorganized, with the bile thickened and unusually dark.

For the subjects on which post mortem examinations were made on cows dying of pleuro-pneumonia in the vicinity of Philadelphia, the committee have been mainly indebted to the kindness of Mr. W. W. Fraily, V. S. In one case the engorged right lung weighed 27 pounds, and the left lung 5 pounds. Besides the ordinary appearances of marbled hepatization and extensive adhesions of the lungs to the sides and diaphragm, there was a patch of diffused suppuration at the posterior end of the right lung, with bloody serous effusion in the pericardium. The heart was of the usual size and appearance; its cavities filled with black blood.

In one autopsy we had the good fortune to have present, at our request, Dr. Joseph Leidy, Professor of Anatomy in the University of Pennsylvania, whose statement of the morbid appearances as observed by him, with the subsequent microscopic examinations of the diseased tissues, is as follows:

"Post mortem examination of a cow which died of pleuro-pneumonia. Examination by

Drs. Leidy and Darrach, aided by Mr. Fraily, veterinary surgeon, in presence of Drs. Emerson and Elwyn:

"Right lung affected with pneumonia throughout, with the exception of a small portion of the summit, everywhere exhibiting the condition of engorgement known as red hepatization. The section of a dark red color, especially at the lower part of the lung, intermingled with some lobules of a light red color, and still containing air. Portions of the lung sunk in water. The bronchus and its ramifications plugged with a fibrinous deposit; the larger ones alone slightly pervious, and the mucous membrane highly inflamed and roughened. The pulmonary pleura everywhere attached to its parietal layer by coagulated fibrinous matter. Weight of the lung 21 pounds.

"Left lung healthy, except a small portion of the middle lobe, which was affected with pneumonia and pleurisy in the corresponding position. The hepatization was of a light red color. Weight of lung 5 pounds.

"The mucous membrane of the trachea exhibited patches of inflammation only near its extremities. Subsequent microscopic examination proved the deposit plugging the air-tubes of the right lung to be fibrin. The air-cells of the pneumonic portions of both lungs were filled with granular nuclei. No parasitic vegetation was detected in any position."

Treatment.—In regard to the remedial treatment of this disease, it is proper to state that we are entirely unskilled in the veterinary art. All that we can properly say upon this important branch of the subject must, therefore, be derived from other sources, and we have endeavored to select from the best of these we could find, especially those emanating from persons who have had the most extensive opportunities of observing and the longest experience in treating the disease. The ignorant demand specifics, and attach but secondary importance to measures of prevention. They seem to lose sight of the old proverb, "an ounce of prevention is worth a pound of cure," and to be incapable of appreciating the importance of hygienic measures, without regard to which medical treatment is so often unavailing.

Mr. Dunn, of Edinburgh, in his excellent treatise upon this disease, observes very appropriately: "The practitioner is often asked, not only by uneducated persons, but by persons who ought to know better, whether any specific has been discovered for the cure of pleuro-pneumonia. But can anything be more preposterous than such a question? How or where can we discover a sovereign and never-failing remedy for a disease which exhibits such diversity of form, and which attacks such vital organs as the lungs? But although faith in all nostrums, specifics, and antidotes must give way before the test of experience, yet the non-existence of a never-failing remedy for pleuro-pneumonia should not be a cause of disappointment or regret, but ought rather to call forth energies and talents in the application of known and successful remedies."

"If the animal attacked be in good condition, and fit for the butcher, we would, generally speaking, recommend the owner to dispose of it immediately, rather than encounter the chance of losing it altogether; for although the animal does eventually recover, it will be so reduced in condition, and so long a time will, in most instances, elapse before it again begins to thrive, accumulate fat, or give milk, that it is frequently more profitable to get rid of it at once."

For the treatment of the disease, we recommend those who have the opportunity to avail themselves of the advice of a veterinarian of established reputation: "Let him be a man of good common sense, and if he has had sufficient experience in the treatment of cattle, he cannot fail to render important service in one way or another. We are sorry to say that, although many zealous and skilful practitioners are to be found in some of our cities, there is not that appreciation of the veterinary art which it certainly deserves, considering the great interests involved in domestic animals, and the diseases and accidents to which these are liable. Little, if any, advantage can be derived from any medical treatment until the cattle are placed under the most favorable conditions to promote their recuperative energies. To the favorable influences exerted through these must be attributed most of the cures claimed for the host of nostrums put forth as infallible remedies. The sick animal should be separated from others with which it may have been placed, and kept clean, cool, quiet, and comfortable, with plenty of pure air to breathe.

"In regard to medical treatment, much discrimination is necessary on the part of the veterinarian, as the disease is so apt to run into that typhus form, the danger from which will be increased by means calculated to diminish the strength of the system. The treatment must conform to the stages of the disease and a careful observation of the symptoms, always bearing in mind that its most striking peculiarity is the tendency to assume a sub-acute and typhus form, which renders it far more formidable than ordinary inflammatory diseases of the lungs, and also the insidious manner in which the disease often progresses for a considerable time before the decided symptoms manifest themselves."

Mr. Dunn is opposed to the general administration of active purgatives. Where the stomach and intestines seem full, and the dung hard and caked, purgatives he thinks indis-

pensable. But they must be used with caution, as the bowels are generally easily moved, and diarrhœa, if once set up, is very difficult to subdue, often proving fatal.

Sedative medicines are in great repute among veterinarians; among these are opium and laudanum, digitalis, extract of belladonna, and aconite. Febrifuge and tonic medicines are also employed, such as antimonial powders and the black oxyd of antimony, tartar emetic and kermes mineral, glauber and epsom salts, common salt, nitrate of potash, hydriodate of potash, sulphur, aloes, &c.

Mr. Dunn recommends tartarized antimony to be given, in the first or inflammatory stage, in doses of four drachms, repeated four times a day, dissolved in about half a pint or pint of cold water, given some time after the animal has been eating. He states that he has seen an ounce administered to a cow morning and evening without perceptible inconvenience. But we think much smaller quantities than even the half of four-drachm doses would be advisable. When the tartarized antimony is given in repeated doses, mixed with about four drachms of nitrate of potash, (saltpeter,) it generally operates advantageously as a diuretic, and, after two or three days, diminishes the fever. It does not appear to reduce, but rather to improve the appetite.

When tartar emetic fails to produce a good effect, Mr. Dunn resorts to the use of calomel and opium, administered in gruel, in doses of one scruple of each, given three times a day. The calomel must not be continued longer than two or three days. Where prostration of strength indicates the necessity of tonics, Mr. Dunn recommends the carbonate of ammonia, from two to three drachms, with one drachm of camphor, twice a day.

In the latter stages, when the pulse is reduced sufficiently, he thinks the best tonic is the sulphate of iron, (or green vitriol,) given in four-drachm doses, twice a day, dissolved in water. The successful use of green vitriol in such cases has been very great under his observation, and this is corroborated by the recommendation of late French authorities. Its continued use in large doses is apt to give the secretions a most intolerable odor, the feces becoming quite black, doubtless occasioned by the action of the iron upon the astringent principles in the food found in the stomach and intestines. To prevent excoriation of the mouth and throat, sometimes occasioned by the administration of tonics and stimulants, it is advisable to mix these with tepid gruel, bran tea, flaxseed tea, or some other mucillaginous preparation. Good sound ale, with the addition of some ounces of ginger, has been recommended as an excellent stimulant in cases of debility. The following prescription may also be occasionally resorted to with great advantage, either alone or in conjunction with other medicines: One pound of molasses, two drachms of sulphur, and two drachms of saltpeter If mixed with gruel, most animals will take this readily, without the necessity of forcing it down. While in a convalescent state, and beginning to recover their appetite, some patients will suddenly look worse, become dull, and again refuse their food. "One is apt," says Mr. Dunn, "to be perplexed with such cases. There is no inflammation or fever to warrant the abstraction of blood; the evacuations appear natural, and yet there is something wrong with the animal. The treatment to be adopted is to give general stimulants, and also large doses of ginger, in order to stimulate the stomach and cause it to resume its impaired function." When serious effusions have taken place to much extent, Mr. Dunn thinks officinal remedies will be of little efficacy, except iodine, in the form of iodide of potassium; of this two or three drachms may be given, dissolved in water gruel, twice a day. Iodine being a costly medicine, he recommends, as a substitute, a mixture of rosin, saltpeter, and ginger, one ounce of each. Tar-balls, given two or three times a day, have been highly recommended, as also tar-oil in teaspoon doses.

Caution in regard to feeding the convalescent.—It is necessary to be very careful in feeding animals when recovering from pleuro-pneumonia, and to limit their food. If allowed the same amount as those in health they may devour more than their debilitated stomachs can digest. Gas will consequently be evolved, so as to puff them up and cause them to be *hoven*, which, as a sequel to pleuro-pneumonia, may be regarded as almost always fatal. Other precautions must be taken to prevent relapses, such as care against exposure to drafts and sudden changes in the weather.

As a general rule, when the sick animals are inclined to eat anything, the diet should be spare and light, consisting of gruel and mashes, with a small allowance of some tender green food. In some cases a cow that will not eat will drink cold water eagerly, and of this she should be allowed as much as she wants.

In a recent number of the Journal d'Agriculture Pratique, published in Paris the 20th of June, 1860, there is an interesting notice of the good results apparently derived from the employment of the sulphate of iron in pleuro-pneumonia, both as a remedy and, more especially, as a preventive. The communication is made by E. Demesmay, a farmer in the Department du Nord, who keeps a herd of 87 cows, several of which had been affected before he commenced the use of sulphate of iron, about $1\frac{3}{4}$ drachms of which, with a few ounces of common salt, were dissolved and administered once a day to each animal with the ordinary mess. . No case occurred in his stables during two months after adopting this treat-

ment. Mr. Dunn thinks that bleeding, in this disease, is only justifiable when cautiously used during the stage of active inflammation. Even sedative medicines must not be pushed too far, or any depleting measures whatever. He relies mostly on tonics and stimulants. There are high authorities who discard bleeding altogether.

The observations of Mr. Barlow, of Edinburgh, relative to the treatment of pleurisy and pneumonia in cattle, and more especially of the practice of blood-letting, are so highly interesting that we cannot refrain from giving them in his own words:

"Pleurisy and pneumonia are not," he says, "always to be treated by bleeding and opening medicines; but in many cases the congestive stage has passed and exudation has commenced before disease is detected, and in others the acute symptoms were never sufficiently obvious. Indeed, it is often remarked by experienced and observant practitioners *that we rarely see such a thing now as the acute pneumonia and pleuritic affections of former days.* They say, too, and we can vouch for the truth of the statement, that pleurisy and pneumonia are not to be cured by that copious and repeated bleeding which formed an orthodox and apparently successful practice even less than twenty years ago. Time was when these diseases were developed in all their acuteness in a few hours, generally in less than a day. The pulse was tense, full, resisting; the urgent symptoms, in fact, made their appearance before time was allowed for much exudation. Now, this fact had, and still possesses, a most important bearing on medical treatment. A copious blood-letting relieved the distended blood-vessels, which, though turgid, were not weakened, and the result was that cases thus early attended to made a speedy recovery. But nowadays the symptoms of pleurisy and pneumonia are less intense; they seem to come on insidiously and quietly, and we often find that copious exudation has occurred before disease is detected. Exudation into the lungs and chest is always productive of much weakness; and if we treat diseases of this character in the same way as we managed more acute cases some twenty years ago, the life of our patient is endangered or sacrificed. *An illustration of this truth is seen in the prevailing pleuro-pneumonia among cattle.* We have all been foiled in treating this disease with anything like uniform success, and, as an act of mutual justice between our employers and ourselves, we often recommend the affected animals to be at once disposed of. Now, many such cattle, supposed to be only a few hours or a day unwell, have been destroyed under my own eye, and I have almost always found disease bearing every evidence of many days' duration. So, then, we very frequently find, when inflammatory diseases of the lungs come under our care, that we have not only inflammation to combat, but we must also contend against extensive exudation, which has destroyed the pulmonary structures. How are we to treat these cases in horses and cattle? I fear there are some who will say 'Bleed them.' Allow me to tell such that when pleuro-pneumonia first appeared in England, about twelve years ago, it was my fortune to see some of the earliest cases. *I bled them copiously and they died.* Still, I sincerely believed in the efficacy of bleeding, and recommended owners of cattle to keep a keener eye upon their stock, so that early and copious bleeding might be employed on the merest suspicion of illness.

"Many of these men were watchful and intelligent, and I am confident that they detected cases of disease as soon as it was possible; they bled them faithfully, and often repeated the bleedings in cases which were most severe. *I look back upon this practice with intense dissatisfaction, for I can charge my recollection with little else than a succession of deaths. I do not think the recoveries amounted to one out of ten affected. Almost every other plan of treatment has been subsequently tried, and I am bound to say that, with me, every other plan has succeeded better than bleeding.* I can also assert, from comparative observation of no small amount which I have carried on in Scotland and England, that those practitioners who bleed most in ordinary cases of pulmonary inflammations among horses, do certainly meet with the greatest number of deaths."

This must be regarded as strong evidence, coming as it does from such an intelligent and experienced veterinarian, who has had such ample opportunities, during at least twelve years, of making himself acquainted with the nature and proper treatment of pleuro-pneumonia

The kinds of food upon which neat cattle are kept, as well as the modes of preparation, exercise an active influence in protecting them from the disease, when prevalent, or in predisposing them to it.

An interesting communication from M. Hamoir, illustrating this subject, is published in the number for June, 1860, of the French Journal of Practical Agriculture. "The pleuro-pneumonia," M. Hamoir observes, "that cruel epizöotic, which has already caused such injury to our agricultural interests, has again invaded our stables. Why it came there, and how its further visits are to be prevented, are points which I think can be now determined."

"A similar visitation of this disease presented itself in 1858, following an abundant crop of sugar beets of very bad quality for the production of sugar, difficult to keep, and affording a pulp of inferior quality. The same circumstances attended upon the too celebrated malady called the *sugar beet disease*, which formerly occurred in 1853."

"May we not conclude from this that when our beets are of inferior quality for the production of sugar, they may contain, in the absence of saccharine matter, pernicious princi-

ples, liable to be converted into residues calculated to injure the health of cattle and subject them to invasions of pleuro-pneumonia?" "This remark has been made by our intelligent and skilful veterinarian, M. Huart. In his extensive observations of the numerous animals he has had occasion to treat, seeking with the closest scrutiny the causes predisposing to this terrible plague, from which we sustain such immense losses, he has not been able to fix upon any other than the bad quality of the pulp and the irritating principles it contains in unusual proportions, after an abundant crop poor in quality."

M. Hamoir had been in the practice of feeding the pulp of the sugar beet, after extracting the sugar, to his beef cattle. This was mixed with cut straw and hay, put into a heap and fermented. But instead of allowing the feed to ferment, he afterwards subjected it to the cooking influence of steam at 130°, (Centigrade,) by which means he supposes the obnoxious principles in the beet were driven off, through distillation or evaporation, and the feed thus rendered healthy to the stock, being infinitely more readily digested and assimilated than the fermented food. The results following this change in the mode of preparing food for his cattle justified him in his conclusions that cattle fed with the fermented beet pulp were liable to be attacked with pleuro-pneumonia, while those kept on steam-cooked beet pulp escaped.

In October, 1856, he says all his oxen kept on fermented pulp mixed with cut straw and hay were attacked with disease, four of them seriously, of which two were butchered. The disease extended no further.

In 1858–'59 there was a terrible visitation, and 1860, after the date of his communication, proved another very bad season. The plague, he says, after having gone the rounds of his neighborhood and ravaged the stables of the commune, leaving in one stable only two alive, in another only one, came to his own, where it seized only upon the oxen fed upon the fermented pulp.

"Five animals," he says, "were placed in the infirmary, and these were treated energetically by M. Huart, by bleeding and the administration of a kermetized dose, accompanied, during several days, with a drachm and a half of tartar emetic, mucillaginous drinks, and common salt. After three days' treatment one of the animals grew so ill that it was consigned to the butcher; the others recovered." The animals in the stable where the disease appeared were now put upon cooked food, when they gradually grew better, so that in about a month the disease seemed to have disappeared. He now returned to feeding with fermented food, supposing that the return of spring and out-door work would restore their health; but the disease returned with renewed violence, and eight oxen were taken to the infirmary. None had died up to the time of writing, and, as he had returned to cooked food, the health of the stock had materially improved. The cattle were in the fields, and it was expected the sickness would thus be brought to an end.

It should be mentioned that M. Hamoir thought that working cattle required food not so readily digested as cattle kept quiet to fatten for beef. With this view he supposed the fermented food better adapted to his oxen. It was among these alone that pleuro-pneumonia prevailed. To those persons who have not the pulp of the sugar beet to feed to their stock M. Hamoir recommends the substitution of beets or other roots, chopped up, which have their nourishing qualities greatly increased by cooking. This is particularly the case with the sugar beet, which, in its raw state, cannot be made use of unless with great caution, as it often produces intestinal irritation and diarrhœa. With milch cows it often decreases the quantity of milk and affords butter of inferior quality. On the contrary, when cooked, it is adapted to all kinds of cattle, and especially to milch cows, in which it increases the quantity of milk, affording butter of an excellent quality, particularly when mixed with a small portion of carrots.

This statement of M. Hamoir is interesting in several points of view, showing, as it does, the frequent occurrence, during many years, of pleuro-pneumonia in the part of France where his cattle were kept, and the immense losses sustained by stock-owners from the disease up to the latest dates. It shows the danger to which cattle are exposed, especially when epidemic poisons may be floating in the air of the neighborhood, by keeping these on an impoverished diet, or upon food in a sour or other indigestible condition. Animals may bear these inconveniences without exhibiting any marked ill effects during healthy periods, but the unwholesome influences manifest themselves whenever an epizöotic arrives. We have seen instances in our own country where disease in milch cows has been ascribed to feeding with grains from lager beer breweries, when those fed on the grains from ale and porter breweries remained well. There may be a difference between the two kinds of brewery grains, making one superior to the other; but at the same time it is certain that the condition in which the cattle were kept was essentially different in many other respects. Sour swill may be regarded as on a par with sour sugar beet pulp.

Prevention.—All prevention is founded upon the removal of animals from the unfavorable circumstances through which disease is engendered or promoted, or the correction of the conditions connected with their keeping. All curative means must be more or less ineffi-

cient, so long as the animals remain exposed to the influences which produced the disease. A sickly stable or cow-house, in which an infectious disease has prevailed, may continue for months, and, perhaps, years, to communicate disease to stock introduced into it. But a sickly stable or cow-house, which has not had a strictly infectious disease in it, may be rendered healthy for stock immediately by the adoption of measures calculated to place the animals under favorable conditions as to cleanliness and ventilation. A stock of cattle has been kept in a healthy condition in an old cow-house, with its open crannies and other accidental facilities for affording change of air to the breathing cattle. The owner has, in time, become able to build a more costly barn, and, ignorant of the importance of securing proper ventilation, had it made so tight and comfortable, as he supposed, as not only to protect his stock from the weather, but keep out the fresh air, and compel them to breathe over and over again the air which has become vitiated by frequently passing through their lungs—air in which reptiles may exist, but which no warm-blooded animals can inhale with impunity. Sometimes the cases may be reversed, and a sickly old stable pulled down, or so judiciously altered as to secure the perfect health of the animals.

Particular attention must be paid to the comfortable drainage of all places where cattle are kept, and the daily removal of the droppings and litter to a considerable distance outside of the cattle houses.* The keeping of pigs in the immediate vicinity of cattle should be avoided.

Stock should not only be kept clean and comfortable, but have plenty of room, for nothing is more injurious in its effects upon the health of stock than over-crowding, either in houses or enclosures, surrounded by board fences or walls. Protection from inclement weather is necessary, but this must never be attained at the expense of keeping out a free supply of fresh air. Drafts of cold air coming immediately upon animals predisposes them to inflammatory diseases. Hence the ventilation must be effected so as to prevent this source of danger. As a certain degree of warmth promotes the taking on of fat and increases the flow of milk, many cattle are sacrificed to the attempt to carry out these objects. In trying to shut out the cold air, the confined and vitiated air is kept in, and this leads to debility, vitiation of the blood, and predisposes to all kinds of dangerous diseases. Warmth attained without ample ventilation is at the exposure of health.

In feeding, care should be taken not to use the same vessels for the well as for the sick. Places where diseased animals have been kept should be not only thrown open freely to the air, but thoroughly cleansed out, and disinfected by washes of quick lime, chloride of lime, &c., sprinkled and thrown upon the floor, sides, and floor above.

"One of the most useful and efficient disinfecting agents with which we are acquainted," observes Mr. Dunn, "is probably sulphurous acid. Although the substance has been generally disregarded, its high claims as a disinfectant have, in his prelections, been urged by Dr. George Wilson, Lecturer on chemistry, Edinburgh. Sulphurous acid is used in bleaching. It is employed in the patent process of paper-making, for arresting the smell resulting from the putrefaction of size, (gelatine or glue.) It is also used in the Manchester dye-works for destroying the intolerable odor arising from the decomposing cochineal, an odor which no other known substance can so effectually remove. Since it thus acts as a bleaching agent, is so efficient in destroying offensive effluvia and in arresting putrefaction, it is likely to prove possessed of the power of neutralizing miasmata emanating from the bodies of animals affected with pleuro-pneumonia or other contagious diseases. Sulphurous acid is obtained by the burning of sulphur, or by decomposing oil of vitriol by heating it with charcoal. Without trusting entirely to the gas evolved, the walls of the building may be washed with a weak solution of the acid in water."

Should that new principle discovered in the atmosphere by Schönbein, and called by him ozone, have anything to do in the production of the epizöotic constitution of the air, it is capable of being destroyed by sulphurous acid gas. It has been found to exist in the air in variable quantities, and is said to produce bronchial irritation.

It has been found that the cattle-herds which have escaped the disease are those where the owners seldom changed their cattle, which were principally raised on the farm, or purchased carefully from herds well known to be healthy. Strange cattle purchased in the market have often been the means of introducing disease in herds, especially when these have been kept under unfavorable circumstances as to cleanliness and imperfect ventilation. Cattle, after a long journey, are very liable to be attacked with disease from a short confinement, especially where the conditions are unfavorable.

Persons keeping herds cannot be too careful to guard against introducing into them unknown cattle. The proprietors of diseased herds, upon finding any of their stock diseased, fearful of individual loss, and regardless of what is due to others, send it to the public

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* In their efforts to preserve the manure from loss from external exposure to the rain, the owners of stock often leave it to vitiate the air breathed by confined cattle, thus often economizing manure at the sacrifice of their stock.

market to be disposed of, often under instructions to conceal the owner's name or residence. Hence no cattle should be purchased to introduce into healthy herds, unless it is positively known that they come from healthy stocks. In the absence of summary laws for the destruction or isolation of diseased herds, this is the only safeguard.

Inoculation.—This, as generally recommended, to secure immunity from the disease, seems to consist in the introduction into the circulation of serum or matter squeezed from a diseased lung. An irritation or inflammation with febrile action ensues, often terminating in death, like that produced from morbid matter, with which persons are sometimes inoculated accidentally, whilst engaged in skinning or dissecting dead subjects. So far as we have read reports of the practice, the results have been anything but favorable. As the matter is generally inserted into the tail, this very often becomes violently inflamed, mortifies, and falls off.

This practice was introduced extensively by Dr. Willems into Belgium in 1850, and from the first reports made very advantageous results were anticipated. But, after several years' observation, and the investigations of a commission recently appointed by the Belgian government, inoculation is condemned. The same sentence has been confirmed by other commissions appointed for a similar purpose in almost all the governments of Europe.

Destruction of cattle to prevent the spreading of their diseases.—This is an old remedy still frequently resorted to in Eastern Europe, and, as we have seen, lately adopted in Massachusetts. The desperate alternative can only be justified by the most direct proof that the disease is capable of being transmitted from animal to animal, under all circumstances, through contagion alone, and where the number of the infected is limited within narrow bounds. When a disease is clearly epizöotic, or capable of being developed through atmospheric agencies, it is evident that all attempts to suppress it by slaughter must prove abortive.

Changes affected by the disease on the milk and flesh.—The question is often asked whether it is safe to use as food the milk and meat of animals affected with pleuro-pneumonia. To this it may be replied that in Europe whenever an animal showing symptoms of the disease is in a sufficiently good condition to make beef, it is slaughtered as quickly as possible for this purpose, and no public prevention is opposed. Not long since the Highland and Agricultural Society of Scotland awarded a gold medal to Mr. Finley Dunn, jr., of Edinburgh, for a treatise on pleuro-pneumonia, in which he says upon this subject:

"Much difference of opinion exists concerning the propriety of using the flesh or milk of animals affected with pleuro-pneumonia. In the first stages of the disease, and before the inflammatory disease has run its course, we are of opinion that the meat is perfectly sound and well tasted, and will afford as much safe nutriment as it would have done previous to the attack of the disease. But when the malady assumes the typhus form, a change has taken place in the animal solids, the secretions are vitiated, the fat, the cellular tissues, and the meat itself, are discolored, showing that they cannot now be safely used as articles of human food."

"In the cases that have come under our observation," continues Mr. Dunn, "no change took place in the quality of the milk. As the disease progresses the secretion diminishes, and is soon altogether dried up; but to the last its color, taste, and odor remain unchanged, except in some instances in which it became thicker and of a more buttery character. If, however, in the latter stages of the disease, milk still continues to be yielded, it certainly should not be used as an article of human food, for the same reasons as above adduced with reference to the flesh of the animals.

The Council of Health at Paris, in a report to the Prefect of the Seine, makes the following statement in regard to the innocuousness of the milk from cows affected by another disorder, namely, the vesicular epizöotic:

"The milk of diseased cows, considered with regard to its affect on the health of human beings, does not appear to be productive of *the slightest inconvenience;* and all examinations of it, whether chemical or microscopical, have not been able to trace any characteristics that might lead to the fear that its effects would be pernicious."—(*Récueil de Mé. Vetérinaiaire, March,* 1845.)

We have heard it stated that pigs to which the milk of cows diseased with pleuro-pneumonia had been given were affected with a cough. In such cases the milk probably came from animals far advanced in the typhus stage. Of course we cannot recommend the use of milk from diseased cows, and only cite authorities to show that the serious apprehensions generally maintained in regard to it are not well founded. It happily occurs that when cows become seriously affected, the secretion of milk generally ceases, or is very small in quantity. Hence the supply of milk from diseased cows must necessarily be very limited. We wish we could say as much for the limitation of the supply of meat.

PLEURO-PNEUMONIA.

BY DR. J. B. CRAIG, WASHINGTON, D. C.

Within the last two years the cattle of this country have been visited by a disease which, although not as yet sufficiently wide-spread nor prolonged in duration to deserve the name of a murrain, yet has very justly been, and to some extent still is, a cause of general anxiety.

This anxiety arises in a great measure from a belief in its identity with an epizöotic which in other parts of the world has proved very mischievous, having in some cases swept away in a short time large numbers of cattle, and having almost always lingered obstinately where it has once shown itself, and broken out, from time to time, in fiercely destructive ravages.

To place, therefore, the short history of the disease in this country in its true light, and to invest it with its appropriate interest, requires an account of its history and character as known elsewhere.

The term Pneumonia, signifying an inflammation of the lungs, is familiar enough to the medical, and even to the non-medical world; since, in cold and temperate climates, such an inflammation is one of the most frequent methods by which death overtakes the human species; and when, as is not uncommonly the case, the inflammation involves the pleura or investing membrane of the lungs as well as the lungs themselves, it is called a Pleuro-Pneumonia, or by some a Peri-Pneumonia, the pneumonia being looked upon as the main disease, and the pleurisy as a complication of it.

Both the pneumonia and pleurisy, as they occur either in man or in the lower animals, are ordinary inflammations, dependent generally on the influences of climate and on the effects of imprudent exposure for their production, and not liable to become at any time more than commonly prevalent without some sufficient cause, such as an increased severity of the weather, being apparent, and not, as far as can be seen, in any degree contagious or infections.

Beside, however, the simple inflammations to which the organs of warm-blooded animals are at times liable, there are others of a peculiar character, which are propagated from one sufferer to another, or which, from unseen causes, attack large numbers at the same time.

Inflammation on a surface—either the skin or a mucous membrane—is sometimes found to have the power of propagating itself, by a sort of transplantation, to similar surfaces in others, the mode in which this is effected being by a conveyance of certain products of morbid action from the diseased to the healthy part. Such inflammations, of which glanders in the horse is an example, are said to have a specific character, and to propagate themselves by *contagion*.

It might be within the bounds of possibility that such contagion should be produced by volatile emanations from a diseased surface, as by the breath from a diseased lung, or by the vapor from the skin in certain skin diseases; but as far as our knowledge goes, local inflammations are not so propagated, but always by means of non-volatile secretions.

We have, again, diseases which affect primarily the whole system, but which produce in their course inflammation of some particular organ, an inflammation which is generally so well marked and so constantly present, as to give to the disease one of its most readily distinguishable characters. Thus scarlet fever is accompanied by inflammation of the throat, measles by a catarrhal irritation approaching to an inflammation, small-pox by a pustule inflammation of the skin, typhoid fever by inflammation of certain glands in the bowels; each disease attacking by preference some particular organ, while at the same time it causes more or less febrile disturbance of the whole system.

These maladies, which are thus both general and local in their manifestations, possess in common the following characteristics:

They are more or less infectious, infection being a mode of communication which is effected by means of the emanations from a sick person, and which does not depend upon actual contact; their duration is pretty uniform for each disease, and is not much influenced by the treatment. When they prove fatal they do so in most cases as a consequence of the inflammations which occur during their course, and when the patient recovers from them he is seldom liable to a second attack.

The explanation or theory which is commonly given of these diseases is, that they are caused by specific poisons, which, being received into the blood, produce in it certain changes or chemical alterations in much the same way that yeast does in substances which are capable of fermentation. Such a change, or the peculiar virus which is produced during the change, acts on the system at large as a cause of febrile disturbance, but also concentrates its effects, as it were, upon some one organ, throwing it into a state of inflammation. When the malady has run its course the alteration which it has effected in the blood remains more or less permanent, so that the set of changes which constitute the disease cannot be readily gone over again at any future time.

The local inflammation which accompanies one of these diseases is commonly only one, although a well-marked symptom; but we find in the human subject at least one malady belonging, apparently, to this class, in which the local inflammation is the only well-marked feature of the complaint; and it would be no contradiction of rational analogy to find in the lower animals infectious and constitutional diseases of which the only very apparent characteristic should be an attendant local inflammation attacking some very important organ and proving a source of much danger.

Inflammations thus arising are apt to present some peculiarities of character, and are often of considerable virulence.

It is not here asserted that epizöotic pleuro-pneumonia belongs to the class of diseases last mentioned, but that it does so is held by some of the most eminent authorities.

As it is only of late years that the progress and the pathological phenomena of the diseases of domestic animals have been at all accurately observed, we can by no means carry their history as far back as we can in the case of those of the human race.

Previously to the present century the only well-recognized epizöotics that are known to have prevailed extensively among horned cattle in Europe were the Eczema Epizöotica, or "mouth and foot disease," a complaint well known in England since the year 1839, and the terrible Rinderpest or Steppe-murrain.

This last-named disease, which is described as being of the nature of a highly infectious typhus fever, terminating in dysentary, is said to be indigenous to the Steppes of Tartary and Siberia, from whence it has descended, from time to time, upon Russia, Germany and other European countries.

It has been estimated that during the eighteenth century the Rinderpest destroyed, in Europe, as many as two hundred millions of cattle.

A few years since the Rinderpest caused much alarm by again advancing against Western Europe, but the stringent regulations which had been established in regard to the contagious diseases among domestic animals, seem to have checked it before it had reached further than to the neighborhood of Berlin, and the commission which was sent out in 1857 by the agricultural societies of Great Britain to inquire into the character of the disease, and the probability of its reaching England, reported that they had to go as far Eastward as Galicia to find cases of it, and that the veterinary cordons of Germany and Holland would, in all likelihood, prevent its reaching the shores of the Atlantic.

The primitive seat of the epizöotic pleuro-pneumonia was, as far as is known, Switzerland and the neighboring Alpine countries, whence, by the movements of cattle consequent upon the wars of the French revolution, it was carried into other parts of Europe. Wherever it has once penetrated it has most generally remained, especially where the locality is damp and marshy, where the cattle are kept in crowded and ill-ventilated stables, and, as in Holland, fed in their stalls and not allowed to graze.

One of the most eminent, perhaps the most eminent, of English writers on the subject speaks as follows of two places in which the disease has been very prevalent, and each of which has a certain historical fame in connexion with it.

In giving an account of his observations in that part of Holland from which pleuro-pneumonia seems to have been recently carried to Massachusetts, he says: "By a statistical return from forty-three villages in North Holland and Friesland it is shown that only eight of them have been comparatively free from pleuro-pneumonia, and in these but very few cattle are kept. In the villages where the disease has prevailed, about a fifth part only of the cattle-owners have escaped upon the whole, but in many every proprietor has had his herd affected. In the first quarter of the present year the official returns show a total loss of 3,655 head of cattle, of which 1,502 died, and 2,153 were killed by order of the authorities, which gives an average loss of about 281 per week."

"We are not surprised at the great extent of these losses, judging from what we saw of the secondary causes of epizöotics in operation in the vicinity of Rotterdam. The cattle are often crowded into houses so thickly that to pass between them is almost an impossibility, while the form and size of the building will frequently allow of a passage only to be made by a person along its centre, where the heads of the animals nearly meet over the feeding troughs, the height being insufficient to stand upright in. No windows exist in many of these sheds, nor any other outlet for light and air except the door. The heat is almost suffocating, and the stench abominable. In such unwholesome and pent breeding places as these, the cattle, often to the extent of forty or fifty in a shed, are kept, for weeks together, to be fattened for the market, by being fed chiefly on the wash and grains which come from the distilleries."—(*Lond. Vet. for* 1858, p. 152.)

Again, in speaking of a visit to Hauelt, in Belgium, where he went in 1852 to examine into the practice of inoculation for pleuro-pneumonia, he states: "The town, which is the capital of the province of Limbourg, is situated on the confines of the great marshy district of Holland. The land around it is remarkably flat, and on one side only is under the plough, being on the other divided by ditches into meadow and parterre grounds. During the last sixteen years it is said never to have been free from pleuro-pneumonia, and in this

time hundreds of animals have died within it. It is a place full of distilleries, and contains from 1,400 to 1,500 cattle in the summer, and upwards of 2,000 in the winter; the animals being fed on the refuse grains, &c., and when fat sent to the markets. From the situation, want of drainage, and accumulation of the filth of the town itself, added to the system of feeding the cattle, the kinds of food, neglect of ventilation of the sheds, and removal of the dung, &c., Hauelt may be considered as the very centre and focus of a disease like pleuro-pneumonia. The cattle, also, of the farmers in the neighborhood are in general very poor and badly provided for, and the sheds they inhabit dirty in the extreme; thus, secondary causes as predisposing to the disease are in full operation, both within and without the town."

Such are the places in which pleuro-pneumomia maintains itself most persistently and commits the most constant ravages, carrying away, year after year, a considerable percentage of the cattle. The non-existence of such predisposing causes as those above mentioned does not, however, protect against it, nor prevent a very great mortality from it. Thus, at the Cape of Good Hope, where the cattle graze freely over a vast open country, the disease, for some years after its first introduction, was more destructive even than it seems ever to have been in Holland and Belgium, showing, apparently, that free intercommunication between herds may operate as powerfully in spreading its ravages as any causes which deteriorate the general health of the animals exposed to it can do.

It has not been shown, however, that in a country where predisposing causes are not in operation, the disease would maintain itself permanently, unless by the importation, from time to time, of fresh cases.

It has been remarked by good authority that "the true pathology of pleuro-pneumonia is one of the *vexed questions of science*," and, as far as any complete and detailed account of it is concerned, this is still true.

The most striking characteristic in the condition of the diseased organs is expressed by the name "exudative pleuro-pneumonia," under which it is sometimes spoken of.

There is copious exudation, both liquid and fibrinous, in the lungs and pleura, the surfaces of the pleura being covered with thick layers of coagulated lymph, its two sides often adherent together, or its cavity filled with serum and crossed perhaps by fibrinous bands.

Under the pleura the tissue which connects it with the lung is found remarkably thickened, and the lungs themselves are crossed in all directions by strong fibrous bands, which tie down the air passages and cells.

Where the lung is not compressed by the effusion in the pleural cavity, its intervenicular tissue is often filled with serum, and the air cells themselves are obliterated, not, it is said, so much by deposit of granular matter in them, as is the case in ordinary pneumonia, as by the compression together and thickening of their walls. The air passages are sometimes blocked up by fibrinous casts, but do not otherwise exhibit many marks of disease.

The animal very commonly dies from the choking up and compression of the lungs, but where it survives the attack it would seem that another set of changes may be put in operation tending to the removal of the effects of the disease.

The fibrous bands which intersect the lungs blend together in part into a continuous sac, in which a portion of the altered lung is enclosed. This remnant of lung, cut off from the rest of the body, undergoes suppuration and gradually dissolves into purulent matter. The sac has then become a true abscess, which, in its earlier stages, differed from the abscess found sometimes in common pneumonia, by containing for a time a piece of lung floating in the pus. This time finally breaks down entirely, and the abscess makes an opening for itself into a bronchial tube, through which it discharges, and, diminishing in size and losing its pus-secreting coat, becomes a small cavity lined with mucous membrane.

The above brief and rough outline may serve to give a general idea of the nature of the organic changes which occur in this disease, but, to convey any exact or minute information on this subject, it will be necessary to make one or two quotations from the best authorities.

In a Prize Essay by Mr. G. Waters, member of the Royal College of Veterinary Surgeons, which is published with woodcut illustrations in the Ninth Volume of the Journal of the Royal Agricultural Society of England, we find the following account of an autopsy: "The disease had reached about its middle stage, and seeing no probability of saving the life of the animal, we recommended it to be slaughtered. On examining the body, we found the abdominal viscera quite healthy, and the pericardium and heart in the same state. The left side of the chest was also healthy. The cortal pleura of the right side was coated throughout its whole extent with thick, tough layers of coagulated lymph, placed one upon another, but which could be easily separated from the subjacent pleura. The thickening was greatest at the anterior and middle part of its cavity. Posteriorly and inferiorly strong and extensive adhesions existed between the lung and the sides of the chest. The cavity of the latter contained about a gallon of light sanguinolent fluid, in which masses of coagulable lymph, resembling lumps of fat, were observed.

"The right lung was enormously enlarged, and its pleura exhibited a ragged appearance,

being covered, like the central pleura, with thick layers of lymph, and presenting here and there large patches of a brownish color, which gave it a mottled appearance. Those variations of color were particularly marked along the lateral portions of the middle and posterior lobes, and the layers of coagulated lymph were not so easily separated from these as the other part of the lung. The pleura, when divested of these accidental exudations, presented in places numerous large and injected vessels.

"On making incisions into various parts of the lung, the pleura was found to be in many places considerably thickened, the portion covering the upper surface of the anterior lobe measuring at its greatest depth nearly three-eighths of an inch; that corresponding to the upper borders of the middle and posterior lobes being at least half an inch in thickness. The latter portion of the pleura, however, became gradually thinner as it approached the inferior or free edge of the lung, where its greatest thickness does not exceed one-tenth of an inch. On removing the external layers of lymph from the thickest part of the pleura, the latter retained a considerable thickness, arising from the state of the subserous cellular tissue, the appearance of which differed from that of the external coagulated lymph, inasmuch as it was firm, and contained cells filled with a gray, semi-gelatinous fluid. The parenchyma of the middle lobe of the diseased lung, when cut into, exhibited a surface of dark red and indurated pulmonary tissue, interspersed with gray points and intersected by repta of a yellowish-white structure, which contained a great number of cells similar to those described already in the thickened sub-serous cellular tissue with which the septa communicated."

In giving an account of another case, that of an animal slaughtered at an earlier period of the disease, Mr. Waters says: "We have represented at letter (*a*) an indurated state of the pulmonary tissue, of a bright red color, and intercepted by thick septa; at letter (*b*) we have a portion of lung near its apex, presenting almost a natural appearance as regards its tissue, but an anormal ove as regards its sub-pleural and inter-lobular cellular tissue."

Of another case he remarks: "The surface of the lung exhibited, as in the previous cases, a thickened state of the sub-pleural cellular tissue; the parenchyma of the lung itself was red and hepatized, and was intersected by septa, resulting apparently from the solidified state of the inter-lobular cellular tissue."

After having described the lungs and pleura in several cases, Mr. Waters speaks of the bronchial tubes: "In the descriptions just given, allusion to the state of the mucous membrane of the bronchial tubes is only made at fig. 3, and in that instance it exhibited but slight traces of the disease. I have, however, had opportunities of examining numerous animals which had been slaughtered during the first stage of the disorder. In several the lining membrane of the bronchial tubes presented in many places patches of a reddish or brownish color without any apparent thickening; but what appeared to us remarkable was a firm, whitish substance, resembling coagulated blood deprived of its coloring matter, which occupied several of the smaller bronchial tubes, to which it was perfectly moulded. The pulmonary tissue was quite healthy. We may also add that we have met with similar appearances in lungs still further advanced in the disease."

The following remarks are then made: "I shall next bring forward some general considerations on the morbid appearances described in the foregoing cases:

"The inflammation of the pleura leads to an exudation of fluid; one part of which settles to the lower part of the chest in a liquid form, more or less sanguinolent and ropy; another adheres to the side of the pleura, and forms layers, to which the term coagulate lymph is applied; in some instances those exudations lead to adhesions between contiguous pleura.

"The effusion of fluid into the cavity of the chest must interfere with the conditions of the lung, especially if the latter be in a healthy state; in that case it will become compressed; but if the lung be inflamed, then the degree of firmness, as well as of volume which it acquires, enables it to resist the pressure of the fluid, so that the presence of the latter in large quantities must then lead to the dilatation of the sides of the chest. The cases described justify the supposition that the pleura is liable to be affected earlier than the lung. Thus, in the third case, the pleura of the posterior lobe was opaque and thickened as far as its base, whilst the corresponding parenchyma of the lung exhibited few, if any, signs of disease; a similar state existed on the opposite side, in which the pleura and lungs were both diseased at the spinal edge of the middle lobe, whilst at its free edge the pleura only was affected.

"The tendency on the part of the pleura to be first affected is not without practical importance. Commencing pleurisy may furnish the first untoward symptoms, and indicate the propriety of active treatment, to which the disease will at that period, in all probability, be amenable.

"The appearance which the sub-pleural cellular tissue presents in this disease is not without interest. It differs from the layers of coagulated lymph adhering to the outer surface of the pleura, inasmuch as it is firm, indurated, and more or less beset with cells. In that respect it closely resembles the inter-lobular cellular tissue, and ought to be considered in association with the diseased state of the lung; but that it may be partly the means of

communicating the inflammation of the pleura to the lung is a consideration not to be overlooked.

"The changes which occur in the parenchyma of the lung in this disease may be considered in reference to two tissues; the one, the vesicular or proper tissue of the lung; the other, the intervening cellular tissue diffused through it in areolar webs, and separating the pulmonary tissue into lobules; hence it may be termed inter-lobular areolar tissue."

Mr. Waters points out, by reference to the wood-cuts, that this last-mentioned tissue becomes greatly thickened in pleuro-pneumonia, and assumes a comparative predominance over the proper vesicular lung structure, or air cells, and air passages. Of this latter he remarks: "Whatever may be the form of the pulmonary cells and their relative arrangement, it is quite evident that, in that stage of inflammation called hepatization, those cells become obliterated. This obliteration is due, in our opinion, to a change which has taken place in the walls of those cells which have become thickened, through an addition of organic matter, in the same manner as the interlobular cellular tissue had become increased in volume." * * * * * "As the middle lobe of the right and the anterior part of the posterior lobe of the left lung are the parts which the inflammation seems usually to attack first, it would be advisable, when examining the chest of an animal, to direct our attention to the middle part of the back in the region corresponding to the angles of the ribs."

In one of the lectures of Professor Simonds, which is published in the Tenth Volume of the Journal of the Royal Agricultural Society, passages occur of much interest in this connexion.

"I have already remarked that the vitiated atmosphere does not act as a direct irritant to the pulmonary tissues or mucous membranes of the air passages—a fact which is proved by the absence of all the usual symptoms of cattarrh, laryngitis, or bronchitis, as precursors of pleuro-pneumonia. Besides, if such were the case, both lungs would be equally affected; whereas it is well known that the disease is very partial, and that the right lung is principally involved. The aerial poison, whatever may be its nature, being carried by the ordinary process of respiration into the air-cells of the lungs, exerts its baneful influence upon the blood in its circulation through the capillaries. The blood, thus charged with something detrimental to its healthy condition, undergoes changes similar to the solids when diseased, and these changes are figured forth in the pulmonary tissues."

Each organ of the body seems susceptible of being acted upon in a special manner by deleterious matters entering into the circulation. Thus the poison of small-pox reacts on the skin; that of glanders on the mucous membranes of the nasal cavities; of rabies on the nerves; of eczema on the lips, tongue, and feet, and of pleuro-pneumonia on the lungs.

The amount of the deleterious matter received at each inspiration appears to be insufficient to interrupt at once the functions of the lungs; for, were this the case, death would speedily come from asphyxia; whereas, we have constant proofs that the disease we are considering is partial in its attack and insidious in its nature, making its way stealthily, being very often unobserved until it has made great inroads upon the constitution. This character of the affection is alone sufficient to create a doubt of its being inflammatory; for inflammation of the lungs, even at its commencement, is marked by unmistakable indications of ill health. The absence of the ordinary symptoms of *pneumonia*, together with the peculiar changes observed in the lungs, have satisfied me that pleuro-pneumonia is not of an inflammatory nature at its outset, and that inflammation is rather the result than the cause of the disease. It is difficult to explain the precise change which takes place in the blood from the operation of the aerial poison; but it appears to me that the vitality of the fibrin is interfered with, and that it, with the albuminous constituents of the fluid, also altered in quality, is transuded from the capillary vessels, and finds its way into the areolar tissue of the lungs, accumulating where this tissue exists in the greatest abundance, namely, in the interlobular spaces." * * * * *

"From this explanation it is evident that I regard pleuro-pneumonia to approach nearer to a *dropsical* than to an *inflammatory* disease. The lungs, if examined at the commencement of the affection, will show that the morbid action commences here and there in their substance, and that these patches quickly increase in size so as to run into each other." * * *

"The exudation of the altered liquor sanguineous is not limited to the lungs themselves, but extends to their investing membrane, the pleura, thus accounting for the depositions of semi-fluid fibrine on their exterior, and the existence of serous effusions in the cavity of the thorax. That these results are not produced by inflammation is clear from the circumstance that in innumerable cases no redness of either the pleura covering the lungs or lining the chest can be detected, both the fibrine and the serum being likewise perfectly colorless.

"Dropsy of the chest may be said now to be associated with dropsy of the lungs. Although inflammation takes no part in the original production of these morbid lesions, still, as previously remarked, it may arise as a consequence, and this, I believe, is generally the case with those animals which recover. The blocking up of the air-cells, vessels, &c., produces death of these structures; and when this is partial and of little extent, portions of the lung will ultimately become detached, and be enclosed in sacs formed by the adhesive

stage of the subsequent inflammation. This will also explain how it is that collections of pus and other morbid products are occasionally met with in our post-mortem examinations of long-existing cases of pleuro-pneumonia."

The statement of Professor Simonds, that the morbid changes which characterize pleuro-pneumonia are to be regarded as dropsical, and not inflammatory in their primary nature, was probably meant by him to be understood with certain qualifications. The blood is doubtless in a condition which predisposes to exudations of serum and fibrin, but in order that such exudations may take place in the pleuræ and lungs, and nowhere else, some peculiar fullness of the blood vessels must exist there—a congestion of either an active or passive kind, and pathological reasons would evidently point to an active excitement, or, in other words, to an incipient inflammation as the true condition of things.

The course of pleuro-pneumonia may, therefore, be presumed to consist in, first, an alteration of the blood, then a local excitement of the lungs and pleuræ, terminating in copious effusion, and afterwards a secondary inflammatory action as the result of the presence of the effused matters.

In a more recent article Professor Simonds still maintains, however, the non-inflammatory doctrine in regard to pleuro-pneumonia, and says: "We have no hesitation in giving it as our opinion that the changes which are *originally* effected in the lung tissue can take place otherwise than by inflammatory action." He also states that the morbid changes commence in the parenchyma of the lungs, and not in the pleuræ.—*Veteriniarian for* 1858, *p.* 97.

Professor Gamgee, of the Edinburg Veterinarian College, takes ground against the non-inflammatory doctrine of pleuro-pneumonia: "The solidified lymph that plugs the bronchial tubes, that gluts the interlobular tissues with inflammatory globules and fibro-plastic cells that the microscope reveals in that lymph, never are found in simple hyperaemia, or congestion due to lack of tenacity of the capillary vessels, which lack of tenacity, according to Schmelz, occurs in consequence of the depressing influence of the causes in operation that act locally on the lungs, as well as generally on the constitution, in lowering the vital powers of cattle affected with pleuro-pneumonia. I have seen some beautiful preparations by Hering of the lymph exuded in the bronchial tubes and air vesicles forming perfect casts of lung tissue; and we all know that plastic coagulable lymph is never seen on mucous surfaces except, and that rarely, in inflammation. There has not been any other specific process discovered whereby such casts can possibly be found.

As the terms inflammation and inflammatory are not susceptible of perfectly exact definition, and seem to cover a somewhat different extent of ground in the minds of different persons, it is not always easy to settle the propriety of their application to a particular case, even when the facts of the case are agreed upon. This much, however, has been made evident by the discussions which have been carried on in regard to pleuro-pneumonia, that the morbid changes are different from those which occur in *ordinary* inflammation, and that when it is called an inflammatory affection it must be borne in mind that the inflammation runs a peculiar course.

Mr. J. Gregson, member of the Royal College of Veterinary Surgeons, at present a veterinary practitioner in the city of Washington, gives the following brief summary of the appearances as observed by himself in autopsies of cattle which had been attacked by this epizöotic, which may serve as a sort of pathological synopsis:

"The lungs, on being cut into, display a *marbled* appearance, formed by bands of organized lymph, which contain between them dark and light colored portions of lung. There is in the chest and pericardial sac effused serum of a bloody tinge, with loose flocculi of lymph floating through it; adhesions of the pleura-pulmonalis and cortalis, with loose flocculi attached to diaphragm."

The difference in color between different portions of lung is also spoken of by Mr. Waters in the account of one of his autopsies.

As the facts relative to the outbreak of the disease in this country have been already laid before the public in several widely-circulated pamphlets, it does not seem necessary to enter at length into the results of the post-mortem examinations made in Massachusetts.

Many of them were upon animals who were in the process of recovery, and they show as a very general feature the presence of the sacs, containing portions of lung and pus, such as have already been spoken of in a quotation from Professor Simonds and elsewhere.

The condition of the pleuræ corresponded with what is recorded by European writers on this epizöotic, and these circumstances strengthen the conclusion which is to be drawn from the general course and history of the disease in New England as to its identity with the true exudative pleuro-pneumonia.

Further confirmation of this conclusion may be got from the results of *post-mortem* examinations of cattle which died in Massachusetts. Thus Dr. Ellis, in examining different portions of diseased lungs, found, in one case, nodules of apparently healthy lung tissue surrounded by "dense fibrous substance;" in another similar nodules, but "infiltrated,

with small globular corpuscles resembling those we see in inflammations;" and again, similar masses completely enclosed by fibrous membrane. These appearances correspond essentially with the pathological changes described by Mr. Waters and Professor Simonds.

Perhaps if numerous autopsies had been made over a large region of country, the disease would have been found to be losing its characteristics as it died out, and blending itself with ordinary pneumonia and pleuritic inflammations.

A question of great practical importance concerning pleuro-pneumonia is, that of its contagiousness or infectiousness. One of the main proofs of the contagiousness of a disease is the general report of its being so. It is objected to this test that in estimating the number of contagious diseases in the human race popular opinion has always gone beyond the reality, and that in many instances the fear which has been entertained of the infection of an epidemic has been found to be without reasonable foundation, men being ever ready to take up such an alarm in regard to a new or a very destructive malady.

When mankind themselves are directly concerned the sense of personal danger generally obscures the judgment; and in contemplating that which is inflicting death on others the probability of its reaching ourselves in a certain way is often exaggerated under a feeling of panic.

When a disease is sweeping away numbers of the human race it is enough to suggest that it may be contagious to make men fly from it as if it were so, and to accept their own terror as a proof of the reality of the danger; but when the question is one of loss among domestic animals, much cooler observation and judgment may be expected, and, at least, those whose interest in the matter is of a general and scientific character, and whose daily experience has made them familiar with the subject, may be supposed to have weighed with some degree of fairness the evidence on both sides.

In those places where pleuro-pneumonia has most prevailed it has been held to be undoubtedly infectious, both by cattle owners and by veterinary surgeons, and various governments have passed and maintained severe restrictive regulations based on the supposition of its being so.

To show the course of modern legislation on the subject—legislation which must be supposed to have been made under high scientific advisement, a few of the orders and proclamations called forth by its recent severe prevalence on the continent of Europe may be cited:

"COPENHAGEN, *June* 18, 1856.

"Proclamation for the Duchies of Holstein and Lauenburg, in reference to the importation of horned cattle from abroad:

"Whereas, according to official information, the pulmonary epidemic has recently shown itself again in horned cattle in several German States, the importation of horned cattle from abroad will not, until further notice, be permitted into the Duchies of Holstein and Lauenburg, unless satisfactory certificates issued by authority be handed in at the same time, stating the place from whence the cattle have been brought, and that in such place no signs of the pulmonary epidemic have appeared for more than six months, the cattle being therein described as accurately as possible."

This, either from having come too late, or from other circumstances, failed to protect the district of country to which it was applied; for we find that in the following year internal regulations had become necessary there, it being ordered that all estates in which cases of pulmonary disease had occurred within the last six months are to be closed, and no removal of cattle from such estates is to be permitted. The cattle are to remain as much as possible in the same stalls, and only to be removed to the pasture grounds of the owners, which are to be fenced round to the exclusion of all other cattle, as it is deemed necessary to remove cattle from their infected stalls to purer air.

In the meantime the Duchy of Holstein had become a source of danger to its neighbors, as will be seen from the following proclamation made for a part of the Territory of Hamburg:

"HAMBURG, *September* 19, 1856.

"It having been communicated to the Senator for the District of the Marshlands that, in several parts of the Duchy of Holstein, a pulmonary disease has again broken out among the cattle; in order to prevent the introduction of this dangerous malady, it is hereby ordered, that for the present no cattle can be brought into the District of the Marshlands from the Duchies of Holstein and Lauenburg without a certificate from the proper local authorities stating that at the places from whence the cattle may come no infectious disease prevails among the cattle, and this under a penalty of fifty thalers for every case of contravention."

In the Kingdom Proper of Denmark a similar regulation had a short time previously been put in force with regard to cattle entering from Holstein, and Sweden and Norway had also

checked the free importation of cattle both from Holstein and from other suspected countries. The same sort of legislation prevailed in other States.

The measures which have been thought necessary when the disease had entered a territory are illustrated by the following enactments for the Territory of Lübeck:

"On the appearance of pleuro-pneumonia immediate notice should be given to the police authorities.

"The affected cattle are to be forthwith separated from the healthy and removed to a distance. If they are put to grass, the meadows must be divided by good fences, and must be at least five hundred paces distant from any in which the cattle are kept.

"The persons who tend cattle are to be directed to note carefully the feeding and ruminating of the animals, and on the slightest indication of disturbed health to have them professionally examined.

"An inspector, duly conversant with disease, is to be specially appointed to attend the sick cattle, and without his permission no animal is to be returned to those which are healthy.

"All animals which die are to be buried five feet deep, and covered with compact earth; the burial places are to be not less distant than eight hundred paces from any road or paths travelled by cattle, and they are afterwards to be surrounded by a strong fence or ditch.

"The diseased cattle are only to be driven on particular roads; the stables in which they were placed when attacked are to be carefully cleaned, and the manure to be covered over with earth.

"None but medical officers are to make *post-mortem* examinations, and these only by permission of the police authorities, and no part of the carcase is to be taken away or used, with the exception of the skin.

"For the removal of the dead animals special vehicles are to be provided, and these are to be kept in proper places, and not used for any other purpose. Persons attending upon sick cattle, or coming in contact with them or with the dead, are not to go near healthy animals, and are to take care that all tools or utensils they may have used are properly cleaned.

"No manure or fodder to be sold from off an infected farm.

"No animal, however slightly affected, is to be killed for food, great vigilance must be used in respect to this order.

"After the disappearance of the disease from a commune or farm for a period of *eight* weeks, it is to be considered as being free from the malady, but for *four* weeks longer the proprietor is not to sell any cattle or other forbidden things from off the place."

Many veterinarians, and among them Professor Simonds, hold that pleuro-pneumonia, although evidently infectious, also spreads by what is known as epidemic influence; or, in other words, advances from place to place, independently of communication between well and sick animals, and in obedience to some unknown, although systematically acting, laws.

That diseases do in many cases spread by this sort of influence is very well known; but in the case of infectious maladies the two actions may be combined. The seeds of infection may be widely scattered over a country, but may not manifest any great vitality, except upon the occurrence of epidemic or epizöotic influence, so that the spread of the pestilence may seem to follow very different laws from those of actual communication, and yet the way for it may have been prepared by a former dissemination of cases of disease, or of substances capable of carrying infection.

As the history of the appearance and ravages of the disease in other parts of the world than Europe has a close bearing on the question of its infectiousness, it may appropriately be given in the present connexion.

In the British possessions at the Cape of Good Hope, where great numbers of cattle are kept, pleuro-pneumonia appeared about the year 1854. It is believed to have been started there by means of an importation from Holland, a bull having been brought from that country in whom the seeds of the disease existed. He was taken sick three or four months after his shipment from Europe, and as there is very unrestrained communication among the cattle of South Africa, the infection naturally spread with great rapidity.

It appears from statistical returns that the number of cattle that died of the disease in the Colony, during the year 1855, was but little short of one hundred thousand, and it has been very prevalent since then, although probably, of late years, with diminished virulence.

The Rev. Mr. Lindley, who had been for some time a missionary among the natives in South Africa, appeared before the committee of the Massachusetts Legislature on pleuro-pneumonia, and testified to the general conviction there that the disease had spread by contagion. He cited some instances in which it could be traced to cattle which had been carried from an infected district to parts of the country which had been previously free from the epizöotic, and mentioned the fact that it was kept out of the territory of the tribe where he himself was resident by vigilant watchfulness against the introduction of cattle while it was prevalent in the neighboring country. On this point he says: "The disease

was brought there by the oxen of an individual who had been into the interior, and when he came home his cattle died. They communicated the disease to all the cattle in that neighborhood, and I never saw more complete destruction. There was not a single head left in all those kraals. The cattle came up to within half a mile of our boundary, and you could look down and see herds of them lying dead. That was three years ago, and yet, when I came away, the disease had not got one inch over that line."

In an article which is to be found in the London Veterinarian for 1856, and also in the Farmers' Magazine, it is stated that the contagiousness of pleuro-pneumonia is "strongly insisted on by the leading medical men and cattle breeders in the Cape Colony."

About the close of 1858 a disease broke out among the cattle on the farm of Mr. Boadle, near Melbourne, in Australia, which was supposed to be pleuro-pneumonia, and was so pronounced by veterinarians who had seen that disease in England. It first appeared in a cow which had recently arrived from England, and rapidly attacked other animals in the same herd.

According to a Report made on the 12th of September, 1859, twenty-three cattle had died on the farm, five had recovered from the disease, but were evidently unsound, ten were ill, of whom four were killed for the purpose of post-mortem examinations by the visiting committee, and there were about forty others of whose condition no mention was made. It was especially testified that there were no local causes, either in the situation of the farm or in the management of the live stock, that would be likely to act as causes of disease, and that the cattle had previously been healthy.

After the disease had manifested itself, Mr. Boadle kept his cattle on his own farm, gave warning to his neighbors of the danger, and employed men to keep other cattle away from his fences. Owing to this commendable conduct on his part, the disease did not spread beyond his estate; and it having been resolved, in a public meeting, to buy and destroy the remainder of his stock, and to take precautions in future against the importation of diseased cattle, Australia seems to have been kept free from any further ravages of this formidable epizöotic.

By the most recent advices, however, we learn that pleuro-pneumonia has not been entirely got rid of in Australia, but seems still to exist, although confined probably to a few herds. During the summer of 1860 it was found to have attacked the cattle on a farm about six miles from Melbourne.

Out of a herd of one hundred and twenty-four nine died apparently of this disease, and one which was sick was then slaughtered for the purpose of a post-mortem examination.

This examination shows a condition of things characteristic of exudative pleuro-pneumonia, as will be seen by the following quotation from the description of it: "The right lung was swollen to an enormous size, three or four times larger than its natural dimensions, and had lost all the normal characteristics of that organ, having become as firm and compact as a piece of beef, and streaked and variegated in color like a piece of marble. The whole herd was soon afterwards purchased and slaughtered; seventy-two of them were found to be healthy, and the rest more or less diseased."

The history of the disease in this country, which is already too well known to make it necessary to enter into details on the subject, carries with it strong evidence of its infectious character, and of its derivation from Europe.

Cattle were shipped from Rotterdam, where pleuro-pneumonia was prevalent, and where, as has been previously shown, causes were in operation which tend to give it a malignant character. Upon their arrival they were placed in a somewhat overcrowded barn with a number of other cattle, so that there was an opportunity for the propagation, in its full vigor, of any infectious disease.

Pleuro-pneumonia broke out there first in the imported animals, next among the domestic, and, ultimately, a large part of the herd died.

The disease did not spread next to the immediate neighborhood, but some calves were sold from the herd and taken by railroad to a distant farm, where one of them was found to be sick upon its arrival. This animal was carried to a neighboring farm, and brought back before its death. After a time pleuro-pneumonia broke out both in the herd to which it belonged and in that in which it had been temporarily placed.

Some of the oxen from this last herd spent a night in the stables of another farm, and there a large number of cattle afterwards perished. There were many cases of exposure to infection before the existence of such a malady was suspected; and it is said that all of the numerous cases of pleuro-pneumonia that occurred in that neighborhood, or, indeed, that came in any way under the observation of a committee subsequently appointed by the Legislature of Massachusetts, could be traced to communication with the animals first attacked.

Very active measures were taken, after a time, against its further spread; but before that was done several animals that had been exposed were known to have been carried to different parts of New England, and it was evidently impossible entirely to cut off the infection. Nevertheless, the disease seems to have been rooted out, or, if still remaining, to be doing

at present but little mischief. It may be that it has died out partly from the destruction or isolation of the diseased animals, and partly from not finding conditions favorable to its propagation, and while the infection at first was virulent, that, as it passed from animal to animal, its rigor diminished and the character of the epizöotic became softened and gradually lost; meanwhile, perhaps, after the manner of some epidemics, impressing something of its peculiarities upon the ordinary diseases of the country, so that it might be difficult to say where or when the specific disease disappeared.

Pleuro-pneumonia, however, is so subtle a disease, and capable, apparently, of remaining so long undeveloped in the system, that its reappearance is always to be feared.

For a time so few cases may occur that they will pass unobserved as belonging to the ordinary affections of cattle, and again from these scattered cases a formidable epizöotic may start itself.

It can scarcely be hoped that it will not, from time to time, make its power felt among us, as it has done in other countries where it has once established itself, and as there is no part of the United States to which there is not a possibility of the means of infection having been carried, those interested in the preservation of horned cattle should everywhere be prepared to watch against it vigilantly and to combat it intelligently.

During the last ten years much interest has been excited on the subject of inoculation for pleuro-pneumonia, a practice which was introduced by Dr. Willems, of Hasselt, in Belgium, a place where, for reasons which have been alluded to in a previous part of this paper, the disease has been very constantly and destructively prevalent.

It may be said, with regard to it, that the obtaining of protection against an infectious disease by means of inoculation is entirely in accordance with medical analogy, and that consequently any plan of this kind is apt to be received and tried with great readiness.

As soon, therefore, as Dr. Willems had announced that his experiments had been successful, inoculation was taken up in several European countries by well qualified veterinarians, and commissions were in the course of time appointed by different governments for the purpose of examining into it. The results arrived at tended, in some cases, to confirm the claims of the new discovery; but it must be borne in mind that the value of such a practice cannot be considered as established by a few sets of experiments, or by a few favorable opinions, but must rest upon the general testimony of those who have had the best means of judging

Now, it may be pretty safely stated that the weight of scientific opinion has been, especially of late years, decidedly against the utility of inoculation, and it is held by many veterinarians to be an exploded error.

A year or two after the first introduction of inoculation Prof. Simonds went to Belgium for the purpose of obtaining information with regard to it, and after his return made some further experiments in England. The results which he arrived at, both from his Belgian and from his English experience, are given at the close of his second Report on the subject made to the council of the Royal Agricultural Society of England, in June, 1853. It may be premised, for the benefit of the non-medical reader, that the question turns not only upon the evidence of actual protection afforded to cattle, but also upon the resemblance of the effect produced by inoculation for pleuro-pneumonia to those produced by a *true* inoculation, such as that for small-pox, this resemblance, or rather analogy, being insisted on by the defenders of the practice as giving it a scientific foundation.

The conclusions of Prof. Simonds are as follows: 1. "That inoculations made by superficial punctures and simple erasions of the skin invariably fail to produce any local inflammatory action, being the reverse of the case with regard to the vaccine disease, small-pox, and other specific affections, of which it is an indication of success.

2. "That the employment of *fresh* serous fluid, and a cleanly made but *small* incision, during the continuance of a low temperature, will almost always fail to produce even the slightest amount of inflammation.

3. "That deep punctures are followed by the ordinary phenomena only of such wounds when containing some slightly irritating agent.

4. "That with a high temperature roughly made incisions, and serous fluid a few days old, local ulceration and gangrene, producing occasionally the death of the patient, will follow inoculation.

5. "That the *sero-purulent matter* taken from an inoculated sore causes more speedy action than the *serum* obtained from a diseased lung, and that '*removes*' cannot be effected on scientific principles.

6. "That oxen are not only susceptible to the action of a *second*, but of *repeated inoculations* with the *ssrous exudation* of a diseased lung.

7. "That an animal inoculated with serous exudation is *in no way protected even from the repeated action* of the sero-purulent fluid which is produced in the wound as a result of the operation.

8. "That animals not naturally the subjects of pleuro-pneumonia, such as donkeys, dogs,

&c., are susceptible to the local action both of the serous exudation from the lung and the sero-purulent matter obtained from the inoculated wound.

9. "That the serous fluid exuded from the lungs is not a specific virus, or lymph, as it is sometimes designated.

10. "That inoculations made with medicinal irritating agents will be followed by similar phenomena to those observed in inoculations with the exuded serum.

11. "That inoculation often acts as a simple issue, and that the security which at times the operation apparently affords depends, in part, upon this, but principally on the unknown causes which regulate the outbreak, spread, and cessation of epidemic diseases.

12. "That inoculation of cattle, as advocated and practiced by Dr. Willems and others, is not founded on any known basis of science or ascertained law, with regard to the propagation of those diseases commonly called specific.

13. "That pleuro-pneumonia occurs at various periods of time after a so-called successful inoculation.

14. "And lastly, that the security of pleuro-pneumonia is in no way mitigated by previous inoculation, the disease proving equally rapid in its progress and fatal in its consequences in an inoculated as in an *un*inoculated animal."

The question still remained in debate, but even on the continent of Europe the conclusions arrived at coincide for the most part with those of Professor Simonds, while in England the opinion against inoculation seems to have soon become firm and decided. In Italy, Dr. Periglio, of Turin, has within the last three or four years published a work on the subject, in which he reviews the experiments and reports that have been made in different parts of Europe, and cites further experiments of his own. He sums up his conclusions as follows:

1. "That this inoculation, discovered and recommended by Dr. Willems, is not based on scientific principles.

2. "That all the facts obtained by the several experiments have concurred in showing that the virus, when introduced into the living tissues, produces inflammation in no way different from that caused by setons, &c., except that it has a greater tendency to a gangrenous result.

3. "That if we admit its revulsive effects, inoculation still possesses no advantages over therapeutic agents in common use in veterinary practice.

4. "That as inoculation is frequently followed by serious and sometimes fatal consequences, it is just and reasonable to give a preference to the usual derivatives.

5. "That should it happen to be, as Dr. Willems pretends, a prophylactic, for which there seems, however, to be no valid ground, proofs are wanting of the inoculative qualities existing in the serum exuded from the lungs, and therefore its employment can be of no benefit."

In the Colony of the Cape of Good Hope, where inoculation has been extensively practiced, it is more favorably thought of than in Europe, but it has not, as far as I am aware, been shown that the confidence in it entertained there rests on other grounds than this: that after pleuro-pneumonia had prevailed for some time cattle owners inoculated their herds, and that afterwards the ravages of the disease diminished. If the plan had been followed of inoculating half of a herd, and then observing the relative mortality of the inoculated and the uninoculated, keeping them as much as possible together, and equally exposed to infection, the results arrived at would have been of much weight.

The usual method of inoculation is by making a deep incision at the end of the tail, and inserting in the wound a piece of diseased lung, or some serum from the lung of an animal that has died of the disease, or has been slaughtered while laboring under it. This is often followed by high inflammation of the wounded part, extending sometimes to more important organs.

It has been suggested that this inflamed wound may act beneficially as a counter-irritant, and this would, no doubt, be to some extent the case, supposing the disease to have commenced, or to be about to commence, in the lungs. There is, however, another way in which such a wound may be of medicinal use apart from the ordinary principles of counter-irritation or revulsion. When the blood has been disorganized by the disease, but before any local alteration has commenced, the existence of an artificially produced inflammation in any part of the body may determine the plastic exudation to take place there, which would otherwise have taken place in the lungs. The blood may thus be freed from a morbid material whose presence in the circulating fluid and whose deposit in a vital organ constitutes the essence of this malady, and it is to be remarked that the condition of the parts which follows upon inoculation during the prevalence of an epizöotic pleuro-pneumonia seems, in some cases, to be characterized by that excess of plastic deposit which marks the specific disease in the lungs.

Among the symptoms of pleuro-pneumonia those are the most important to be known which are the first to manifest themselves, and of these the cough, the appearance of the hair, and the disinclination for food are regarded as being the most observable.

In a proclamation of the Senate of Lubeck, May 14, 1856, cattle owners are informed

that "the special symptoms of pleuro-pneumonia are a husky cough, which is increased particularly after the cattle have been watered or moved about, less inclination for food, indifference as to chewing the cud, dulness of the hair, and its rough appearance in particular places, and fever after the symptoms have continued for some time."

Mr. Waters says: "The first and most constant symptom of this disorder is a cough of a dry or husky character, which may continue for a greater or less period before other symptoms of a more decided character present themselves."

Professor Simonds, in a lecture on the subject, which is published in the Tenth Volume of the Journal of the Royal Agricultural Society, speaks as follows: "It will often be observed that oxen at pasture, when the disease is commencing, will early in the morning be separated from the herd, standing under the hedge with their backs arched, coats staring, and refusing to eat, while as the day advances they will join the rest, and appear in their usual health. A slight but husky cough will be occasionally recognized, and now and then the breathing will be increased, as if the animal had undergone some extra exertion, while in milch cows there will be a diminished amount of milk in addition to the above symptoms. As the disease progresses the cough becomes more frequent and husky, the respiration is hurried, the pulse increased and somewhat oppressed, the appetite diminished, rumination suspended, bowels constipated, surface of the body chilly, &c. In the more advanced stages the respiration is difficult, labored, and painful; the patient is frequently lying, or, if standing, the head is protruded; the mouth is covered with a frothy saliva; the muzzle is cold; rigors occasionally come on, and the pulse is rapid and often indistinct. An enlargement of the right side of the chest can generally be detected in this stage of the malady; percussion gives a dull sound, and auscultation detects an increased bronchial respiration with a crepitating rôle in some parts, but a total absence of sound in others."

Mr. Lindley, in describing the disease as seen in South Africa, mentions the staring of the coat and the cough as the first symptoms, and further remarks: "Other cattle have such a cough, and you will hardly be able to distinguish it, but you will observe that this is not momentary, but is kept up day and night; and then this gets to be a cough that comes from the very bottom of the lungs—a very severe cough—which continues until the animal dies."

For further details in regard to the symptoms of pleuro-pneumonia the reader is referred to other papers contained in the present report.

Questions connected with the treatment of pleuro-pneumonia belong, strictly speaking, to the province of the veterinary practitioner, but as, in this country at least, the management of cattle in disease as well as in health must be in the hands of their owners, guided, perhaps, by the advice of the medical practitioner, it is important that some knowledge on the subject shall be widely diffused.

As a specimen of a practical routine plan for the treatment of cattle during the prevalence of this epizöotic, a quotation may be made from the papers of Mr. Horsfall on "Dairy Management," which have been published in the Journal of the Royal Agricultural Society:

"My feeders are strictly enjoined, without loss of time, to report to me any appearance of ailment, a practice which I strenuously recommend to any one who concerns himself about the treatment of his cattle when sick, more particularly as regards the disease of which I am speaking, the chance of success in which depends essentially upon early application.

"The first appearance which arrests the feeder's attention is loss or partial loss of appetite. If, on examination, I detect any of the symptoms which characterize pleuro-pneumonia, viz: cough, quickness or deepness of respiration, loss of cud, and acceleration of pulse, intermittent warmth and chilliness of horns and feet, I proceed at once to bleed till the pulse is sensibly affected. This requires usually five or six quarts to be taken."

Mr. Horsfall then gives, in warm gruel, a laxative and refrigerant dose, of which the main ingredients are, eight ounces of epsom salts, half a drachm of tartar emetic, half a drachm of digitalis, and five ounces of flour of sulphur.

"On a renewal of the difficulty of breathing or acceleration of pulse, I repeat the bleeding to a less extent, say three quarts, and give likewise the tartar emetic and digitalis in the gruel." Flour of sulphur and molasses is afterwards given morning and evening in sufficient quantities to keep the bowels moderately open. The animal is carefully watched and kept in a room which is warm, well ventilated, but free from draughts. A wine-glassful of brandy is given night and morning if the pulse becomes feeble and the animal appears weak."

The following extract from a lecture of Professor Simonds may be considered as a brief, systematic essay on the treatment of pleuro-pneumonia from one of the best authorities in matters of veterinary medicine:

"The first remedy to which I shall allude is blood-letting. The propriety of abstracting blood will depend on the stage of the malady and the amount of symptomatic fever which is present. It must be done early or not all, for in proportion to the extent of the effusion

so will be the debility of the patient. To bleed late is to hasten a fatal termination; but if we attend to the animal at the very commencement of the disease much good may be done by a bold blood-letting. No rule, however, can be laid down as to the quantity to be abstracted, but the pulse must be carefully watched, and as soon as its character is altered the bleeding must be suspended.

"I do not recommend an early blood-letting for the single purpose of allaying the febrile condition of the system, but to withdraw a portion of the vitiated fluid which has laid the foundation for and is quickly building up the disease.

"Another remedy of frequent adoption is the exhibition of purgative medicine. In most disorders it is of the first importance to clear out the *primæ viæ*, as thereby we not only remove offensive and offending matters from the system, but subdue the excitation which is present by the nauseating effects of the medicine, which is further assisted by the agent increasing the intestinal and other secretions. If constipation is present, even in the advanced stages of pleuro-pneumonia, a gentle aperient may be given, but cathartics should be avoided. I have already stated that diarrhœa often comes on as the case approaches its end; and it should be remembered that this morbid condition of the bowels is very easily excited by purgative medicine. Cathartics, like blood-letting, must be used cautiously. They are admissible at the beginning of the affection, but rarely afterwards. The ordinary saline mixtures are as good as any, but they ought to be given without the large doses of ginger, &c., with which they are too generally blended.

"Diuretic agents stand next in the list. Medicines of this class stimulate the kidneys to increased action, and their employment is found to be associated with far less weakening effects on the lower animals than is the case with purgatives. They may, therefore, be frequently and quickly repeated. Diuretics carry off a considerable portion of the watery parts of the blood, and hence their great use in affections of a dropsical nature. The nitrate of potash is one of the safest and best of our diuretic agents, and I especially recommend it in the treatment of pleuro-pneumonia. I do this for several reasons, among which is the established fact that the alkaline carbonates and nitrates are of the greatest benefit when the blood itself is in an abnormal condition. One of the best ways of using the nitrate of potash is to add it to the water which is given to the animal to drink.

"Sedative medicines have been extensively employed by some persons in this disease, but in my experience they have rarely proved of service; nevertheless, their occasional administration will be needed, especially when the circulation is much excited. Dover's powder, opium, and extract of belladonna, are the most valuable agents of this class. Calomel, in combination with opium, has also its advocates, and in certain cases I have given it with advantage.

"Diaphoretics, or medicines which promote the secretions of the skin, are beneficial, but their action should always be assisted by warm clothing, without which they are nearly useless. The tartrate of antimony and potash is one of our chief diaphoretics; I have found it, however, to act too freely on the mucous membrane of the intestinal canal, and to produce thereby considerable mischief; as a rule I do not employ it, and more especially in protracted cases of the malady. The other preparations of antimony are not open to the same objection, and these, with the Pulvio Jacobi, should be selected. To effect a copious secretion of perspiration the skin of a recently killed sheep, applied while yet warm to the back and sides, surpass everything we have as yet tried.

"Diffusible stimulants and tonics are, in my opinion, the most valuable of all remedies, and invariably I have recourse to them as early as circumstances will permit. Of late we have heard much of the beneficial effects of brandy as a diffusible stimulant, and doubtless in the second stage of the malady it has proved of service. I prefer, however, the sweet spirits of nitre and the solution of acetate of ammonia in combination, the ammonia in excess.

"In the advanced stages, however, even these agents fail to support the system against the debilitating effects of the disease, and we must now employ both vegetable and mineral tonics; the sulphates of iron, and quinine, gentian, ginger, columba, and the barks are the best. Before concluding these remarks on the treatment, which are, of course, very much condensed, I shall allude to another remedy which has many advocates, and properly so, in my opinion, namely, counter-irritation, or the application of stimulating ointments and liniments to the sides of the chest.

"This class of remedies is generally adopted when active inflammation pervades some internal organ, and with the happiest results; and although I do not view pleuro-pneumonia as essentially an inflammation still we can easily understand that benefit will follow the use of counter-irritants. By the long-continued action of an agent of this kind, the inflammation which it excites in the skin will be attended with effusion of the albuminous parts of the blood into subcutaneous tissue, and thus we artificially produce a disease here analogous to that of the lungs, and thereby give relief to those organs."

Mr. Waters, in an Essay already quoted from, recommends that, where a cough is the only

symptom remarked, a seton or peg be inserted in the dewlap, and a dose of salts given, and that, as soon as febrile symptoms are apparent, the animal should be bled, and placed in a warm and well-ventilated shelter. The blood should be allowed to flow in a full stream until some decided effect is produced on the pulse. After the bleeding Mr. Waters administers a dose of epsom salts, nitre, and tartar emetic; one pound of the first, one ounce of the second, and one drachm of the third, given in two quarts of warm gruel, and repeated if necessary.

After the first stage of the disease has passed, antiphlogistic treatment should be discontinued, and extensive counter-irritation resorted to, together with the exhibition of calomel, opium, and antimony, as follows:

Rx.—	Hydrargyri chloridis mitis	℈j.
	Antimonii et potassæ tartratis	ʒj.
	Pulvis opii	ʒss.

Mix and give three times a day.

For a counter-irritating ointment Mr. Waters gives the two following recipes: Biniodide of mercury, 1 part; pounded euphorbium, 4 parts; Spanish flies, 12 parts; lard, 18 parts. (The euphorbium here meant is evidently that of the London Pharmacopœia—a gum-resin.

A tonic mixture, containing two drachms each of sulphate of iron and of powdered gentian may be given twice a day in case of great debility. Diarrhœa is best checked by the administration of chalk and opium.

The authorities above quoted agree in recommending bleeding as an advisable measure at the beginning of the treatment; but there are, on the other hand, a number of veterinarians who looked upon blood-letting with distrust, and hold that it increases the mortality of this disease.

Medical men are aware that, in regard to the treatment of a number of diseases in the human subject, a similar difference of opinion has existed, and that there has been, in fact, a tendency to form extreme parties, so to speak, on the question of bleeding or not bleeding.

In inflammatory affections the benefit to be got from bleeding has been found to depend on a variety of circumstances; not only upon the nature and the seat of the inflammation, and the condition and constitution of the patient, but also upon the climate and upon what may be called *the prevailing epidemic influence.*

The doctrine of the occurrence of alternating epochs of tolerance and non-tolerance of depletory measures seems to rest on pretty strong grounds, although the fact is one which has never been positively demonstrated, and which, in the present state of our knowledge, is not susceptible of a satisfactory explanation. The probable truth of the supposition, however, together with the known liability of particular epidemic diseases to vary in character, makes it desirable that a trial should be had of the effect of blood-letting upon an outbreak of pleuro-pneumonia in a new place. The trial should not be by employing bleeding for a time, and then abandoning it, but by using it with a certain proportion of the whole number attacked, and comparing their mortality with that of those sick at the same time, in whose treatment bleeding has been omitted.

The doctrine of the non-inflammatory character of this disease does not necessarily bear against the propriety of blood-letting in its treatment; for, it may be observed that, in human medicine, the affections in which bleeding is most imperatively demanded, and universally practiced by physicians, are not those of an inflammatory nature, but those in which the pathological condition is that of congestion with progressing or impending effusion, and such we must believe to be the condition of the lungs in the commencement of an attack of pleuro-pneumonia.

The object of opening a vein is to diminish the pressure in the blood-vessels, and by that means to check the progress of exudation; and there can hardly be a doubt of its efficiency in doing this, if employed in proper time, and not after the vessels have already relieved themselves by effusion.

That this disease depends essentially upon a disorganization of the blood, and has a general typhoid tendency, which is aggravated by loss of blood, is also to be borne in mind, and those who bleed freely must expect to run some risk of losing patients from subsequent debility. On the other hand, the animals, in whose lungs the effusion is cut short by an early bleeding, will be in a better condition when convalesence has been established than those who, after having suffered extensive local mischief, have been carried through the attack by a supporting plan of treatment.

The indications of treatment in pleuro-pneumonia, after bleeding or in the omission of bleeding, are 1st. To unload the blood-vessels by stimulating the different secretions. 2d. To diminish the force of the circulation as far as may be done safely. 3d. To direct the circulation away from the lungs. 4th. To promote the absorption of the exudation by special means, as by mercurials; and 5th. To support the animal against depression and exhaustion.

A dose of salts, rendered more active and more depressing by the addition of tartar emetic,

fulfils the first three of these indications; but it is evident that English veterinarians are not inclined to repeat such a measure very frequently. The less debilitating action of diuretics is regarded with favor by Professor Simonds, and no doubt efficiently fulfils the first indication, and, to some extent, also the third. To maintain the skin in a state of activity by warm apartments, clothing, and diaphoretic medicines, and to excite it still more by the use of counter-irritants, meets better perhaps than anything else the indication of directing the circulation away from the lungs, and is to be attended to throughout the disease.

The desirability of stimulating absorption, and of dissolving and removing plastic deposit, would naturally suggest the use of mercury, and we find accordingly that the exhibition of calomel and opium is recommended by good authority as a regular part of the treatment, and Professor Simonds considers it advisable, in some cases at least. The extent to which it is to be used might, very rationally, be governed by the amount of plastic deposit which should be found in post mortem examinations, made during the particular epizöotic outbreak then prevailing. If the lungs should be found very dense and firm in their texture, strongly marbled in their appearance, with an evidently great development of the fibrous element, and the pleura be thickly coated with plastic lymph, and joined together by numerous adhesions, active mercurial treatment would seem to be called for; but if the lungs are dark and soft, and the adhesive inflammation in the pleura not very strongly marked, it is fair to presume that the administration of calomel might be the better dispensed with.

Tartar emetic may be given for the purpose of keeping down the force of the circulation and of augmenting the secretions, but it should be omitted if danger should appear to exist from debility or from diarrhœa.

The disease is generally marked by a tendency to debility, caused both by a primary impairment of the blood and by the interference with the function of respiration consequent upon the compression and solidification of the lungs. Toward the latter stages a supporting treatment often becomes requisite, and we find that alcoholic liquors and ammonia have been much used for that purpose, as have also the bitter tonics. Professor Simonds recommends a mixture of sweet spirits of nitre and solution of acetate of ammonia, with an excess of ammonia, and the simple solution of ammonia has been proposed and used. The carbonate of ammonia would probably be found a very reliable and satisfactory ammoniacal stimulant.

The use of stimulants would be the more necessary where bleeding had been freely employed in the commencement of the disease; and a good guide for their administration, and especially for that of alcoholic stimulants, is to observe whether the patient becomes feverish and restless under their use, and if so, to discontinue them. Brandy is given by European veterinarians, but in this country whiskey is a good and cheap substitute for it.

A rational plan of treatment, which would include as much perhaps as could be done with assurance of benefit, or, at least, as much as is thought to be actually necessary, would be to bleed—if bleeding seemed advisable—as soon as the disease had manifested itself, to purge once, and to see that the bowels did not become afterwards constipated, to keep the animal warm and in a pure atmosphere, to apply some counter-irritant to the chest, to feed on gruel, warm mashes, &c., and to add some whiskey to the gruel, if a stimulant should become necessary.

Some of the other measures pointed out by Professor Simonds and others may also be tried, but if the patient should continue worse, it should then be recollected that the advice of experienced veterinarians is, not to attempt to save an animal in which this disease has taken, in its latter stages, a decidedly unfavorable turn.

There are certain medicines which have been held to have some specific virtues in the treatment of pleuro-pneumonia, either as prophylactics or as remedies, and of these the sulphate of iron seems to have the strongest testimony in its favor. The preparations of iron are undoubtedly most excellent means of improving the condition of the blood, when it has been exposed to disorganizing influences; and such influences may be supposed to prevail during an epizöotic of pleuro-pneumonia.

Most of them, and among others the sulphate, possess, in addition to their chalybeate properties, astringent powers which may check somewhat a tendency to copious effusion. Other astringents, such as sulphate of copper and alum, have been employed on the hypothesis of a necessity for giving strength and imperviousness to the blood vessels, and so preventing their contents from exuding.

Arsenic has been thought of, and, as it is a good alterative and tonic, its effects might be tried upon cattle who had been exposed to the infection of pleuro-pneumonia.

When an animal is actually sick, however, it is objectionable to use many drugs, or to give anything for which there is not what is termed a "plain therapeutical indication."

It need scarcely be said that remedies should be especially abstained from, the reasons for using which spring only from the assertions of persons ignorant of the medical art, and untrained to guard themselves against deceit and mistake in matters relating to it.

Whatever medicines are used care should be taken that they are genuine and of good quality, and much more caution is needed in regard to this than is commonly thought. The best safeguard is to obtain everything from the most reliable sources, but at the same time a few remarks may be here made upon some of the simplest tests of purity of those medicines which are most employed or are most worth trying in the treatment of pleuro-pneumonia.

The sweet spirit of nitre is much used in this disease by the English veterinarians, but, in this country at least, it is very seldom met with of proper quality. A good test of it is said to be afforded by its boiling point, which should be at about 160° Fahrenheit.

Carbonate of ammonia should be bought in hard lumps, and when heated a little it should volatalize entirely.

Arsenic and calomel, when placed on a pretty hot shovel, should also be volatile without residue. When calomel has been stirred up with clear rain water and allowed to settle, adding solution of ammonia or hartshorn to the water should not turn it white and cloudy.

Whiskey and other distilled liquors may be tested in the following way: About a teacupful of it should be put in a warm place and allowed to evaporate. If the vapor given off toward the close of the evaporation has an offensive odor, and produces, after being inhaled, a feeling of irritation in the back of the mouth and the throat lasting for some time, it may be set down as of bad quality; and if, when the evaporation is nearly finished, the liquid has an acid taste, or if the residue which is finally left is large in quantity, and molasses-like in character, adulteration may be more than suspected.

Tartar emetic is more apt to be pure when bought in crystals than when bought in powder. It should be completely soluble in twelve times its weight of lukewarm water.

It has been said by some that the mortality is so great in pleuro-pneumonia that the best plan is at once to kill those animals that are attacked by it, and even to destroy a whole herd, if it shall seem to have been generally infected. This should no doubt be done where there is a hope of checking the spread of the malady by such means, and we find that European governments have paid very large sums, indeed, in compensations to owners of cattle who have thus sacrificed them.

At certain times and places the chances of cure may be so small that the interest of the individual owner may be best consulted by killing all who are taken sick; but, even when the disease seems most intractable, it should be borne in mind that the earlier cases of an epidemic are the most fatal, and that after the first fury of the outbreak has passed a milder character of the disease is to be expected.

There are precautions to be taken for the protection of cattle from pleuro-pneumonia which relate, 1st, to the importation of it from without, and, 2d, to the existence of circumstances which favor its propagation at home.

The time during which it will remain latent in the system is so great that a quarantine of several months seems desirable when an animal is suspected of having been exposed to it, but even a much shorter quarantine may be highly useful, for it has been shown by experience in various parts of the world that the most probable time for the development of pleuro-pneumonia is soon after cattle have been exposed to considerable hardship and fatigue, as when they have just come from a long journey. Indeed, it would seem as if such influences may develop the disease in those who might otherwise have escaped it altogether, and at any rate caution should be observed in not over-driving cattle, and in not putting among other cattle those who have been recently over-driven or exposed to harassing voyages by sea or land.

Even when pleuro-pneumonia is widely spread in a community and cattle have been generally exposed to it, precautions should be taken against the importation of fresh cases; for infections and contagions seem to be governed by a law somewhat similar to that which prevails with regard to the vegetable world, viz: that the seed which has recently been brought from a distance is apt to bring forth the most abundantly. It is at least evident that cases imported from localities where the disease is very active and virulent are peculiarly apt to communicate fatal infection.

The continued existence of the disease in a country is kept up by a want of isolation among cattle, by the practice of selling them after they have become infected, and by the keeping of animals in unclean and ill-ventilated buildings.

The mischievousness of the first two causes will appear to all, but experience has shown that the agency of that last named is perhaps the most efficient in rendering pleuro-pneumonia persistent and destructive, and that all other means of getting rid of it may prove ineffectual if individuals are allowed to keep their cattle in foul and unwholesome air, and thus make their stalls and barns an abiding place of the pestilence.

BEE-CULTURE.

BY WILLIAM BUCKISCH, HORTONTOWN, TEXAS.

While Agriculture in almost every respect, and other branches of human knowledge, have been advanced and improved, little progress has been made in the Culture of Bees, though they were provided for by law among the Jews, Greeks, and Romans.

Even in the oldest literary monument and earliest book of history and religion, the Bible, the richness of Canaan is depicted in these words, "The land that floweth with milk and honey." Rome's greatest poet, Virgil, found this lovely creature attractive enough to make it the subject of one of his most pleasing didactic poems.

In the Middle Ages laws were passed for the protection of bees, and large and well-organized associations were formed for the promotion of bee-culture. (*Zeidelgesellschaften.*) Coming still further down in history a variety of laws and regulations were made, not only by the government of Austria, under the auspices of Maria Theresa, but also in other countries. A collection of these laws of the different countries, relating to the bee, chronologically arranged, would form an appropriate subject in a historical point of view, and also help to promote the interest manifested in bee-culture.

In Germany, from 1847 to 1853, the government of Prussia tendered every promotion and encouragement for the introduction of an improved bee-culture. It encouraged the object of the Bee Association of Silesia—a society over which the writer had the honor to preside for several years—not only by officially recommending it, but also materially by granting it the franking privilege and making donations through the Board of Rural Economy.

Sugar having gradually come more and more into use, honey was in a great measure dispensed with, though in many respects preferable for domestic use, and it is well known that for medicinal purposes it cannot be relinquished.

The ant, it is true, may be looked upon as an example of industry, but it is an industry causing the destruction of trees and field and garden plants, while the bee assists the farmer and gardener, fructifying many blossoms of fruit trees and shrubs, and those of the rape, clover, and other field and garden plants by conveying the pollen to the pistils. Worthy of all imitation for cleanliness, it permits not a single one of the millions of atoms used in building its combs to be wasted, well knowing that its most dangerous enemy, the moth, will in a few days make its appearance and lay its brood in such waste as threatens its very existence. That there is strength in union none seem to know better than the bee. When an enemy has intruded too heavy for one bee to remove, as many more as can find room will seize upon this intruder, and if then too heavy for such an effort, as a mouse or a large bug, for instance, it is pasted over with wax, so as not to become injurious even its decomposition. In building their cells thousands of bees hang one upon another, without detaching or tearing asunder the feet of the upper ones. By means of the heat generated by this bunch the fine wax layers used for building their wonderful comb are sweated through the rings of their bodies.

All their work and action springs from harmonious co-operation. There are usually fifty thousand required for a colony, this being the average number of workers in a proper bee-hive, as twenty thousand make but a small colony. These thousands form a republic, every citizen of which is quite disinterested, while all are at the same time actuated by a public spirit that can never be excelled. Every bee not only increases the common store of honey and wax, but it is also prepared fearlessly to expose itself at any minute, if the honey is in danger of being robbed, or if the safety of the queen or any of its co-workers is threatened. Though the labors of the bees are so various; though thousands are devoted to carrying in the pollen, other thousands to building cells, and yet thousands more to feeding the young bee-worms, closing up the cells, smoothing the walls of the bee-hives, cleaning the floor, filling up the chinks or cracks and holes, and to many other occupations, there is never any difficulty among them as to who is to perform the pleasant or the unpleasant, the light, the heavy, or the difficult work. Besides, there never are too many nor too few engaged, there is no delay or momentary confusion even in their work, every one of them instinctively perceiving what is immediately required, and carrying out the same. Such a perfect equalization of rights and duties as is shown by the bee-hive never was exhibited by any human government in all its wisdom and good will. Yet there is one among them superior to all others, of greater length by about one-half of the body, provided with longer and yellow

feet, yellow rings around its body, and a tuft of hair ; the only one of its kind in a colony, called the queen or mother bee, because she lays all the eggs in a hive, from which the bees of the hive—workers, drones, and even the future queens—are hatched. If each of the workers, furnished as it is with a sting, cheerfully risks its life for its queen, this is from love only, as the queen neither governs, commands, gives orders, or advice. All she does is to lay an astonishing number of eggs, (sometimes three thousand a day,) and fix, each of them accurately by one end of its oval figure obliquely to the upper back wall of the cell, having first crept into each cell to examine and cleanse it, and perhaps paste some sticky matter to the spot where it is to be fastened, unless the egg has already received such matter from her body. It is a remarkable fact, too, that the queen, though able to eat without the aid of others, does not usually do so, but is fed all her life by the workers, offering to her honey in a great quantity, as the large deposit of eggs likewise requires much consumption. It is probable that this food, being of excellent quality and easy of digestion, is prepared by the workers for the queen herself. Certain it is, that during the period in which she lays most of her eggs, she would not have time to get her food out of the cells. The queen never deposits more than one egg in each cell, neglecting not even a single one. The color of the eggs is not brown, as stated in the Agricultural Report of 1857, but it is white in every country. There is a difference, however, in the color of the honey and wax, (they being independent of each other,) varying in all shades from white, yellow, green, gray, and brown, to red, according to different countries and seasons. The difference in these colors is owing to the variety of honey and pollen collected. Even in the same country, and during the same season, honey and wax of different colors are produced ; but the wax varies less than the honey in its shades or colors. The quality of the honey also depends upon each collection respectively. During the fall of 1858 there was such a drought in this section of the country (Texas) that the bees could only collect their food from bad herbs, probably from the so-called wild tobacco, (*Lobelia inflata*,) and the honey made from it had a bad taste, as if a great deal of pepper had been mixed with it. But the next year, after a copious rain, the honey had so delicate a taste that it was not inferior to any variety of honey in the world. The pollen, which is also called bee-bread, serves not only as food for the young bee-worms, but also for the old bees during winter, when they are confined in their hives. In the spring, when the old bees make a great deal of wax by sweating, they require a large quantity of pollen. If this be not found, (for instance, in the early spring of northern countries,) they will be busy in gathering flour of the rye and other cereals within their reach, or from mills near by. The pollen stored in the cells has merely the appearance of having been manufactured into a particular bee-bread. As often as a brood is hatched, the cells become of a darker color from the skin that remains after the transformation of the worm into a bee. When the wax is melted and the skins and bee-bread that remain have been separated, its original color is again restored, which almost everywhere is yellowish white. There are but a few countries, as the Crimea, which furnish a deep yellow or reddish prime-color. There is also some difference in the consistency of honey. When fresh it is everywhere in a fluid state, and thinnest in warm countries. The older it grows the more solid it is, crystalizing like sugar candy and gradually becoming so hard that it can scarcely be cut with the knife. Its loss in aroma is supplied by mildness of taste. In this state its palatableness is unsurpassed ; it may be eaten alone in large quantities without injury, while fresh honey can only be so with bread and butter, as else less easy of digestion and irritating the palate by its acrid quality or sharp taste. This acridness is probably derived from a mixture of juice contained in the poison-bag, and is for the purpose of imparting to the honey its piquant taste, and to preserve it from turning sour. No other transformation of the juice of the blossoms seems to take place in the honey-vessels of the bees ; for, immediately after their arrival in the hive, they pour this honey into the cells, however short the distance may be, and even though the flowering linden be immediately above the hive or form its roof.

The brooding-place, or the spot where the queen deposits her eggs, ought to be in the middle of the hive, and in the cold of winter it must not occupy any other position. But this brooding-place is often ten times larger in the spring, and during a good season it reaches even to the walls. Not unfrequently, in bee-hives made of glass, or on the back door being removed, the queen may be seen depositing her eggs on the outside of the last comb-work, which she continues without allowing herself to be disturbed. On the first of July, after a long period of drought, the writer had to remove all the combs until he reached the middle ones, in order to find one with eggs and worms to place in another hive, which had lost its queen some five weeks before, an operation which he repeatedly tried with this queenless hive. No hive, however, should be entirely without eggs and brood. Even in the cold North, and during the three months of November, December, and January, a healthy hive ought not to be deficient in eggs and brood. In February, though still very cold, a greater supply may be already found.

The queen not only successively deposits eggs of one kind, but, without knowing the

quality of her eggs, she lays them indiscriminately in all the cells, just as they issue from her body, all being of equal description, and shaped into fertile (worker) eggs, or infertile (drone) eggs, merely by the act of laying. If, for instance, a young swarm is placed in a small hive containing nothing but worker-cells the result is that there will be nothing but workers, or, if filled with drone-cells, there will be nothing but drones.

But where, in the former case, are the worker-eggs, and where, in the latter, are the drone-eggs? It also often happens that half of the comb consists of small bee or worker-cells, while the other half is composed of the larger or drone-cells. Now the queen deposits in the same quarter of an hour the worker-eggs as well as the drone-eggs; the latter are sometimes deposited even first, if she happens to get first on that part of the comb. It has likewise been shown, by the most accurate dissection, that the bee has only one ovary, with eggs of but one kind. The queen never owns a palace to dwell in, neither are the queens provided with special homes, but they all live together in the passages leading through the combs, the object of the cell being threefold, *i. e.*, to receive the honey, the pollen, and the eggs and brood.

The solidity of the comb may well serve as an example to the architect; for the bee knows how to keep together more than a hundred pounds of honey and bees in delicate frames of wax, the single partitions of which cannot sustain the five-hundredth part. No thread is required, and the tender walls even give way to the gentle pressure of a finger.

The industry of the bee is proverbial. In the Northern part of Germany it will be found abroad engaged in collecting honey as early as 3 o'clock in the morning, and so continuing up to 9 o'clock in the evening, when it might be expected to return tired and rest. But whoever keeps his ear close to a hive during the night will hear a deafening humming and buzzing noise of all sorts of voices arising from the work the bees are performing within the hive. Thus the building of the combs then goes on more rapidly, as the whole colony takes part in it, a fact which has led some persons to the erroneous belief that the bees build their cells merely at night, while they may be observed doing this work during the day time. The fineness of eyesight required for this operation is really surprising. This case seems to the writer the only example of an activity lasting for days and weeks without interruption, and without support either by rest or sleep. It is doubtful whether the naturalist will find in the whole world another animal provided with the same inexhaustible perseverance, and this is the more striking, as not even winter affords them a complete stand still or winter-sleep, though it gives to the bees of the North a semi-lethargic sleep. In the South the bee is employed all the year round, though it does not manifest the same astonishing activity which is shown by her Northern sister during the short period in which she can there gather her food. In the South, however, she is kept back from her excursions only by the cold North winds, and but for a few days, rarely for a full week.

Another remarkable feature deserves mention. Bees are capable of living for days, weeks, and even months, without air—at least, without the accession of fresh air. In the North, where they cannot fly out for at least from four to six weeks, (in the Northern part of Germany they must be kept during hard winters over four months within their hives,) a special winter-stand is required, or they must be buried in the ground. Most bee-raisers are in doubt whether the bees can be safely buried for months. This fact being of great importance on account of the less quantity of food required during winter, (not, however, because of its total stoppage, as supposed by many,) the writer made repeated experiments on the subject. Toward the end of November, 1848, two hives were buried two inches deep in the earth, pressed down rather hard, and without allowing any air-hole. On the 11th of March, 1849, they were dug out again. They were all lively, not having had to endure the cold of 2.7° Reaumur, = 92.7° Fahrenheit above the ground. All this was done in the presence of witnesses whose names could be given.

The following points, which were first established by Mr. Dzierzon, are important and remarkable. They met with many attacks until they were finally and satisfactorily proved:

There is only one queen in each colony, and she must be impregnated within three to thirty days after her birth or creeping from her cells. The impregnation must take place in the open air by the queen meeting with a drone. For proof of this a number of queens, after their return from going abroad, were immediately driven out of the hives and examined, when they showed signs of having had connexion with a male bee or drone; as, for instance, the genitals of the queen were still somewhat open, contained foreign matter, and often even the generating organ of the drone itself. Besides, a queen and drone were often found on the ground in actual connexion with each other. Finally, the queen never deposits good eggs if, before flying out, her wings are much cut, when still young, while mother-bees already impregnated will remain so, even should their wings be greatly shortened. The drone dies in this act of impregnation, having previously poured its seed in a bag located behind the ovary. Thus the queen is at one time impregnated for her whole life, lasting from two to five years, while the life of a worker lasts only six months.

The drones never collect honey, carry water, hatch, feed the worms, nor perform any other work. They consume the honey carried in by the workers, and, at a certain time, are stung to death by them. If there is scarcity of food they are often, in their young state, torn from their cells. Some persons suppose that they generate by their heat a high temperature, and thus promote the hatching out of the brood. But they are not there at the very time when their presence for this object would be most required—in the cool spring, when the hive contains the greatest brood, and when this brood must be hatched without them. Now, if they make their appearance during the heat of the summer, they are not wanted for the purpose of assisting in the hatching, because the heat of a populous hive is then such as to bring out the young brood of itself. This heat is also enough for the worms and chrysalides. Even if a hive throw out three swarms during a summer, the fructification of the queen (the only business of the drones) would then require but a few drones, instead of some three or four thousand contained in many a hive. Now, if on the one hand Nature, by a large number of drones, provides for this important work of propagation, the intelligent bee-keeper, on the other hand, takes care that his bees build a few large cells only for hatching drones, which greatly diminish the store of honey, so that sometimes wire traps are used to catch them. Twenty drones are enough, instead of thousands. Or should there not be a single drone in a hive, the young queen flying out would still accomplish her object, if there are other hives containing drones on the bee-stand.

After impregnation, which is sometimes only the result of repeated excursions, the queen never leaves her hive. Whoever believes in any such absence afterward is most certainly mistaken. It is only when the bees have increased so rapidly as to send out a new swarm, that the old queen leaves with this first swarm, which is called the *primary* or *previous* swarm. The subsequent swarms or colonies, however, which are called *after* swarms, have, of course, only young queens. Should an after swarm contain more than one, they fight each other even to death to obtain the sole possession of the hive. It often happens that the surviving queen has been injured in this struggle. Only in very rare cases do the workers become parties to it, as it goes on between the two young queens.

Three days after impregnation the queen commences laying eggs. From each fructified egg either a worker or a queen may be produced, and, to produce queens, the workers provide a special arrangement of the cells. Under common circumstances, where there is a queen, after the hive has become populous and desires to swarm, the workers construct special queen-cells. Instead of these being horizontal, they are suspended perpendicularly from their edges, as described and shown in the Patent Office Report for 1857, page 107, &c. For the sake of safety, often many such cells, even up to fifteen, are begun at the same time. The inner width corresponds only to the worker bees, and is not wider, as stated in those pages, but the wax walls are thicker. The worm from which the queen is produced, during the eight days, before it is shut up and changed into the chrysalis, receives better and more food. This fact has been shown by analysis. If the queen is driven off or perishes before laying an egg in a cell, the bees so deprived of their queen procure a new one by prolonging a worker bee-cell containing an egg or a worm. They prolong the horizontal cell by hanging upon it a curved and pointed bag, and this very prolongation implies the principal cause of the worms being transformed into a queen. It is not a mere selection. These queens which are made from necessity, it is true, are a little smaller than the others, but there has not yet been discovered any want or deficiency in their qualities when compared with the other queens hatched in the common way and in pendant cells. By means of this structure of the cell the body of the queen is extended one-half its original length, and the organs of production are formed to perfection, while those of workers, though also females, are stopped and stunted in their growth and development. Should the bees not succeed in supplying themselves with a queen, which may arise from the fact that the queen, after impregnation, on her return, gets into a strange hive, where she will be immediately stung to death, or because all the queens are killed in their struggle for the sole possession of the hive, then the worker bees left without a queen are unable to create another, unless the accident has been noticed in time and a remedy applied. In this distress the workers try to help themselves by one or more of them laying eggs; but even this will not save them from destruction, as such eggs merely produce drones, which, instead of collecting honey, only add to a more rapid consumption of its supply.

The bee-cells, as is well known, are of two kinds, most of them being small and destined for workers, while a less number are larger, wider, and designed only for drones. In the process of laying the queen puts the hinder part of her body into the cell; the egg, being detached from its ovary, slides in the laying tube, and must pass by the bag heretofore described, which contains the seed of the male. Owing to the narrowness of the smaller cells, the egg must touch the bag, and thus becomes fecundated. But the eggs laid in the spacious drone cells do not touch the bag, and hence do not receive fecundation.

The writer will here introduce the following recapitulation gathered from the remarks of

the Rev. Mr. Dzierzon, of Karlsmarkt, Silesia, the distinguished bee-master of Europe, on the classification, characteristics, and destiny of bees :

"*Workers.*—The most numerous portion of bees in a hive are the workers, so called because they perform all the work, both without and within the hive. On warm days, when the temperature is at least 12° R., = 59° Fahr., they are frequently seen on flowers, sucking out the honey-juice and pollen for their combs. Many erroneous assertions have formerly been made as to their sex. Sometimes a portion of them have been said to be males, and another alleged to be females. Then again they have been described as neuters. But the sting with which every worker is furnished, and which is peculiar only to the females of the hymenopterous insects—bees, wasps, and bumble bees—indicates their female gender. Their sex, however, is not fully and properly developed. Though ovaries are clearly indicated, these bees, for the greater part, are not able to lay eggs, and even though a few be found the ovaries of which are so developed that they can lay eggs, they will produce males simply, and never workers. The only part they take in breeding is to build the cells for the young, warm both the eggs deposited by the queen and the larvæ coming from them, feed these larvæ, and cover their cells when, about the seventh day, they have completed their growth, after which the larvæ spin themselves in, then are transformed into chrysalides, and, biting through the cover of their cells, emerge as perfect bees. This takes place with the workers in from nineteen to twenty-one days, according to the temperature, commencing from the egg; with the drones in twenty-four days, and with the queens in sixteen days.

"When young the bees devote themselves more to their home duties, for which reason the young bees are sometimes called brood bees, because the preparation of pap for feeding the brood forms their principal, though not their only, business. They also build cells for the reception of honey, which is clarified and covered by them, for which purpose they prepare the wax, &c. The materials—such as honey and pollen, water for rarefying honey that is too thick or has too great an amount of honey, as well as the resin and bee-glue for stopping crevices to prevent both drafts and the entrance of foes and to fasten the combs better to the cover and walls—all are gathered by the older worker bees. On fine days they are generally found more without than within the hive, carrying materials together so long as their wings are not too much worn out; and for this reason these older workers are often called carrier bees or carriers.

"The younger brood bees make their appearance, but for a short time only, at noon, in the warmest time of the day, in clusters around the fly-hole, (the so-called *preamble*,) in order to get acquainted with the stand, and to clean themselves, while flying about, of the excrements which rapidly collect in them while preparing the wax and feeding pap. After this they either return to their domestic work or a portion of them flies off to the fields to gather in honey.

"*Drones.*—These bees are recognized in their flight by a louder, deeper, and more humming sound. Their body is less tapering, with hairs on the hind part, and considerably thicker than that of the workers, and hence also require wider cells. While of worker cells it takes about 25 to a square inch, (see fig. 1,) only 16 drone cells are needed to fill the same space, (see fig. 2.) The main distinction of the drones from the workers is the want of a sting. As to their sex and design, the most contradictory and absurd opinions are found in the various books on bees. But, on examining their body, no one can doubt the fact that they are the males among the bees, destined to fecundate the young queens. This taking place only in the air, as in case of kindred insects—bumble-bees, wasps,

Fig. 1.

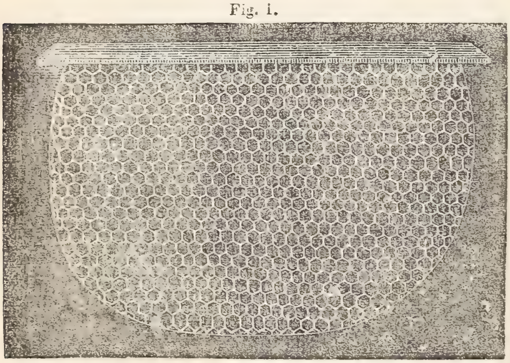
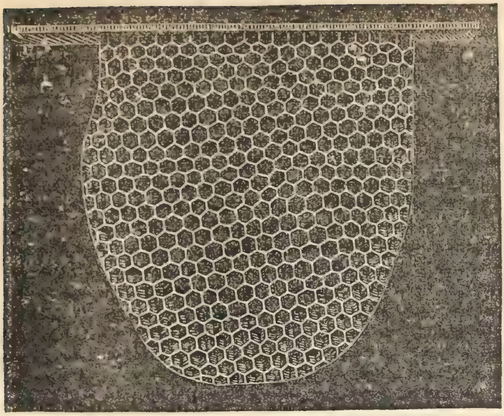


Fig. 2.



and even ants—a large number of drones is always found, so that the queen may more certainly meet with one, and not remain unfecundated—a fact which has not been understood by many bee-keepers. As young queens are only hatched and fecundated at the time of swarming, and as they are then impregnated for their whole life, the drones, at the period when the bee food diminishes, naturally are expelled from all the hives that have a fecundated queen, being only tolerated by the colonies without a queen. This expulsion is called the battle of drones.

"*The Queen.*—The most remarkable among all the bees of a colony is the queen, or mother-bee. She, too, has formerly been held to be a male; and Virgil, in the fourth book of the Georgics, always calls her *Rex King.* The German name also, *Weiser, Guide, or Leader*, proves that she was thought to be a male, and was erroneously believed to lead off the swarm, showing the way. Though this error was long ago abandoned, still there are many bee-keepers even now who assert that the queen lays eggs only for workers, and that the drone-eggs are laid by certain workers called drone-mothers. They have not been able to understand how it is possible for the queen, if she really lays all the eggs, to lay the female ones exactly in the worker-cells, and the male eggs in the wider drone-cells; and from the fact that even workers sometimes begin to lay drone-eggs in hives without a queen, they conclude that this is the case when there is a queen, thus disregarding all experience which teaches the contrary."

The most violent controversies were carried on upon this question by the principal bee-keepers of Germany in their journals on bee economy, until the Rev. Mr. Dzierzon succeeded both in showing that the existence of the drone-mothers, previously claimed as regular members of a bee-hive, was a mere fiction, and in causing his theory to be generally recognized even by men of science. This theory, in an easy and simple manner, solves all the difficulties and uncertainties in which the history of the propagation of bees has been involved for centuries.

The young queen, as before mentioned, is impregnated by a drone only once in her life, and high up in the air, for which purpose, after becoming monarch of the hive, and having reached her age for copulation, at the time of the usual *preamble*, she goes abroad several times until her object is accomplished. In this copulation it is not the ovary that is fecundated, as formerly supposed, but a little bladder (seed receptacle) towards the end of the body is filled. Every egg to be deposited has to pass by this bladder, and is individually fructified. Now, we have seen several queens—some borne from their cells with defective wings, some with wings purposely cut, and some hatched when there were no drones at all in the hive; none of which could possibly be fecundated, and on examination they showed also an empty seminal bladder, yet they laid eggs capable of being developed, from which, however, were produced males or drones only, even though the queen endeavored to produce workers, and so laid her eggs in small cells. From this it is beyond all question that males or drones are produced from the eggs developed in the ovary of the queen, in consequence simply of the power of maternity, but that such eggs must be fecundated by the fluid in the seminal bladder, in order to yield female bees, either working-bees or queens.

The impregnated queen being able either to fecundate or not an egg before it is deposited, it is as easy to explain how she can lay female or male eggs at pleasure, when the particular cell requires it, as it is the inability of queens not impregnated, or of workers who are incapable of being fecundated, to produce a female progeny. This proposition, however, though merely offered as a solution of the difficult question respecting a bee-hive, has been most violently controverted on the ground that there can be no life without fecundation.

"The new theory would have remained, perhaps, forever an hypothesis but for the discovery made at the same time by Professor Leuckart, of Giessen, and by Dr. Meissner, of Göttingen, Germany, of the fecundation of the eggs of insects. This is not effected by a simple external contact, together with an excited state so caused, but by means of one of those moving fibres, spermatozoa, existing in numberless quantities in the semen pene-

trating the egg, through the so-called micropyle, a small opening at one of its ends. With this basis it has been possible to ascertain the correctness of the new theory. Professor Von Siebold succeeded in preparing the bee-eggs so that he could look into their interior. While no trace or symptom of any fecundation was visible, either on the inside or outside of the drone-eggs, of which he examined quite a number with the greatest care and attention, from one to three of those moving threads, could be plainly seen in the eggs for workers. The correctness of the theory reached by these experiments having been scientifically demonstrated both by means of the microscope and the dissecting knife, Professor Von Siebold made similar observations on other insects, and embodied the result of his discoveries in a work entitled "True Parthenogenesis in Butterflies and Bees," (Wahre Parthenogenesis bei Schemetterlingen und Bienen,) a translation of which might form a welcome addition to the English literature on this subject.

"The natural history of the bee, already so interesting in itself, has thus become more important for the naturalist; for what could excite more attention than the observation of these wondrous germs lying hid in the tiny bee-egg, and from which either a male or female is produced, according as it had been, or not been, fecundated. Not less worthy of admiration is the fact that the female becomes either a common unproductive worker-bee if the egg is deposited in a certain small cell, and provided with inferior food, or a queen if it is deposited in one of the larger, acorn-shaped queen cells, and furnished with the richer and more nourishing pap for its food. This queen lays daily as many as 3,000 eggs, and deposits a million during her lifetime, commonly lasting four years.

That the queens are not produced from a particular or different kind of egg, as formerly supposed, but from eggs or small larvae, which but for the larger cell and better food would have produced common or worker-bees, had been previously discovered by Pastor Schirach. But he was mistaken in believing that larvae of three days only might be reared into queens, the observation having been made by Dzierzon, and confirmed by others, that from the larvae of the workers, so long as they are not covered—that is, up to their sixth day—perfect females, or queens, can be reared by covering and lengthening their cells, and by providing them with richer and more nourishing food, for the development of sex takes place only at the transformation of the larvae into chrysalides.

"The general reception of this theory, finally, is mainly owing to the Italian bee brought into Germany by Dzierzon in the spring of 1853. This Italian bee is very differently marked from other bees, the first two rings of its body being of a yellow color, forming, as it were, a yellow band, which is visible even as it flies. The queens especially are of a beautiful golden color, changing towards the hinder part of the body into black. The Italian drones, too, are plainly distinguished from common drones, though not as strikingly so as the queens and workers. As this Italian bee, though of a different breed, is essentially the same honey-bee as the gray or black German bee, and as individuals of both breeds copulate and become one colony, the queens of one breed may be transferred into the hive of another. After a series of the most interesting observations, the Dzierzon theory was thus most strikingly confirmed. If the queen of a common gray or black colony is removed and replaced by an Italian or yellow queen, (which, however, must not be put in before three days, and kept in a cage from one to two days for her own safety,) not only will Italian workers be produced, but also Italian drones, a decisive proof that the drone-eggs are also laid by the queen. In crossing—that is, if a common black queen is impregnated by an Italian drone, or an Italian queen by a black drone—the result will be apparent in the female progeny only; but the drones produced by the queens are either German or Italian, according to the queen producing them, for the simple reason that the substance in the seminal bladder has no influence whatever on the drone-eggs. By exchanging the queen either of a black or an Italian colony in the manner above mentioned, the length of the bee's life can be most accurately determined, because the period when the former generation was of a different color can be ascertained with certainty. In spring and summer, when the bees rapidly wear out through continued activity, soon become old and die, their lives average hardly two months. If in this season, such a black colony will after two months be thoroughly Italianized, with, perhaps, not a single black bee in it. The bees hatched in August and September live much longer. In winter, when all activity ceases, no brood being deposited, they are scarcely affected by age; and as those which have survived the winter may continue even to the months of May and June, some will live from eight to nine months. Those that are hatched in February and March, compelled to lie idle for weeks and even months in certain localities, may live from five to six months. This may also be set down as the average length of their life, though individual bees, especially in hives without queens, where almost all activity ceases, may reach even the age of a year.

The drones would attain the same and perhaps a greater age, because they do not perform any work except flying out at noon on fine days in order to meet the young queen in the air as she goes abroad at the time of copulation. But as they are expelled when the

pasture ceases, they live only about four or five months, according to the time of their birth. Those last deposited are often torn out and thrown from the hive before their development.

The few drones which accomplish the real object of their existence—the impregnation of the queen—do not survive after it has been done. As soon as the male organ appears the drone is motionless, dead. The highest age among bees is attained by the queen, and she is also developed in the shortest time. Her usual age seems to be four years, though they are sometimes seen full five years old. As her productiveness is diminished in the fourth, sometimes in the third year, it is advisable to replace her by a new and sound one, as the success and yield of a hive depends mainly on a vigorous and productive queen.

Numerous prejudices exist injurious to bee-raising, some of which require particular refutation, as most frequent, and having apparently so much weight with many persons. First. It is alleged that bees yield no profit, or at least so little that they will not pay for keeping, and, as to the increase of national wealth, that their yield is hardly of any importance. Secondly. It is said that in view of their propensity to sting, it is always a risk and even danger to keep bees. Thirdly. It is affirmed that it is too difficult, and requires too much time to give the bees such a management as is most conducive and natural to them.

As to the first objection, it is true that no revenue can be expected from irrational and unnatural treatment of bees. But wherever this industrious little animal has been properly cared for during a tolerably fair season in countries which are not wholly deficient in honey plants they have always yielded their keeper a corresponding return, not only compensating him for the loss of his time, but also blessing many a bee-raiser with prosperity. The question, however, is a more serious one, whether individuals or whole families can derive their principal sustenance from bee-culture. Even this question can be answered in the affirmative. In Germany there are no places altogether destitute of honey, but in this country both extremes may sometimes be met with, for there are sections suffering from prevailing dryness, where neither trees nor shrubs will grow, and where the bees must, of course, starve. Again, there are other sections, and these form by far the greatest portion of the country abounding in honey, where the bees can collect but the smallest part of this abundance, no matter how much they store away. In dry places and poor seasons the bees are reduced to a mere handful around the queen, and they will even cease their excursions for honey as useless. These hard times in our hot climate usually occur in midsummer, while in the Northern parts of the United States and Germany many hives are killed by cold and want of food. Many hives, too, there, after consuming a large quantity of honey for several months, will often starve, though a little more would have saved them, which, however, during great cold, it is very difficult to give them. The conditions for bee-culture in this country are, on the whole, quite different from those of Germany. Wet summers there, with cool weather, cause the ruin of bees, however fertilizing they may be to the crops of the field. The dry summers, on the contrary, are the more favorable to them, because the drought, instead of diminishing their food, tends only to increase it. But in this country, here in Texas, where dryness is usual, the rainy seasons are a real refreshment to man, animal, tree, and every other product, and especially so to bees. While in the Northern States the spring, including June and half of July, forms the main period for gathering honey, this is done in the fall at the South. During good weather the bees gather from January to August only what they want for their own use, while during the three months of September, October, and November, they gather all their surplus for man. Many a hive with us (in Texas) containing but a handful of bees in the month of August requires only sufficient rain to become populous again within three weeks. In another three weeks every room and space of the hive will be filled up, while if it should enjoy favorable weather for two or three weeks more, every space that has been emptied will be again filled with a second crop. Generally speaking, the South is far more adapted to the bee than the North. Though an oppressive heat is not favorable to it, even if it rest a little during the warmest hours of the day, yet cold is much more injurious, as it causes death. While it is well known that it can live at the equator, it is not yet ascertained how far North it may do so. In Sweden it still affords a surplus of honey.

The most favorable conditions for bee-culture are found in those countries which combine great warmth with sufficient humidity, where none of the millions of blossoms is deficient in its nectar drops formed from the abundance of juice; whereas in dry and unfruitful regions they are almost wholly wanting. These drops of the blossoms as well as the pollen form their only food, with the exception of the honey-dew produced from the aphides, which the bees assiduously collect from the leaves of the linden, the plum-tree, the oak, and other trees. That bee-culture in the South pays a larger profit than at the North is shown by the mere fact that each colony at the North requires at least from fifteen to twenty pounds of honey as food for winter, while at the South it hardly requires five pounds, being about fifteen pounds less, that may be counted among the profits of the bee-keeper. As regards the annual yield, figures will also here decide, as in other cases. A colony, including the hive,

which of course is often worthless, is sold here (in Texas) for from five down to three and often two dollars.

Whether the price be high or low, the profit will be at least 100 per cent., in case a new colony is obtained. But in favorable seasons, two colonies may be expected from a hive, either natural or artificial. The intelligent and practical bee-keeper may annually raise ten new stocks (swarms or hives) from one old stock. But the question is, whether the supplies of Nature will nourish his weak colonies, which will certainly require a locality extraordinarily rich in honey, such as the writer at least has never known. Dr. Blumenau, of Brazil, stated in 1852 that more than a dozen of new swarms issued from one single hive in that country. They, however, usually went off into the woods, an evil peculiar to the whole of this continent. Such an increase might be possible in a very rich locality; besides, Dr. Blumenau is reliable authority, as his moderation in his other descriptions show. At a distance of only thirteen miles from the writer's residence, the bee-keeper, Mr. Spangenberg, was observed putting in eight new natural swarms from his two old hives; three swarms escaped under his very eyes, and judging from certain circumstances, there were at least three more which are also presumed to have escaped without having been noticed. These make fourteen new swarms from two old hives, or seven from one, and this in a very stony and sterile locality, a small portion of which is capable of cultivation. Five of these eight new swarms had already during the first summer a considerable surplus of honey. The new hives, of course, will only be productive when they furnish their own honey and wax, at least up to the next favorable season. This is not usually the case at the North, while at the South they commonly afford a surplus of honey.

The yield of honey annually produced from one hive at the North of Germany will, on an average, hardly exceed ten pounds unless the summer season is unusually favorable; but in the United States, at least at the South, and this in dry localities, for instance in Western Texas, there are but few years where a stock, on an average, yields less than twenty pounds a year. It is true there are also colonies which have lost their queens, or which have become weakened from some other cause and have not saved anything for the coming year, except their lives and their health. But such are brought into the average by the prominent hives yielding one hundred pounds of honey and over; for a vigorous colony in an excellent hive, and enjoying favorable seasons, will sometimes yield as much as two hundred pounds a year. Estimating the price of honey at only fifteen cents a pound, the yield of the average amount of twenty pounds is three dollars, or seventy-five per cent. of the purchase money at four dollars a hive. From this the cost of management and other incidental expenses must be deducted. This amount, however, is inconsiderable, and diminishes in proportion as this branch of industry is extended. If bee-culture is practiced on a large scale, the value of the time given it is divided among so large a number of hives that it is employed to advantage. The very fact that one individual is enough to keep so many hives in order has a great deal of weight in this question. Under the hands of a man ill-fitted for his business not even a small number will thrive, while the intelligent and practical bee-keeper can take care of five hundred, and make besides a portion of the hives for the new colonies. Should he require assistance during the period of swarming, it will be but little and but for a short time. What branch of agriculture can show such another instance of one man making by his labor over one thousand dollars clear gain a year?

The most natural and profitable way of keeping bees is for every farmer to put up as many hives as he may want for producing his own honey and wax. With sufficient assistance the bee-master can keep one thousand hives and even more. Many a person may be deterred from such an increase by the cost of the hives, but he should consider that the increase is only gradual, so that the intelligent bee-keeper will be prepared for it whenever it becomes necessary. Even an expensive bee-house may be doubly paid for from the profit of the honey obtained in the first year. Besides, a large number of hives can be more economically put up than a less one; if the first hives, for instance, should cost two dollars, the last ones will not be more than one-fourth of this amount. A small number of colonies require good hives, while a larger number may thrive in hives of not so good a quality.

For a bee-house or bee-stand to contain a number of distinct hives, unburnt bricks may be recommended, as being very cheap, warm in winter and cool in summer. It should be so arranged as not to permit the individual colonies to reach or disturb each other. In places abounding with honey, such buildings are as profitable and as lasting as are barns and stables in localities mainly devoted to the raising of cattle and the cultivation of cereals.

From two to five hundred colonies may be sustained on the square mile, as the honey-drop that has been sucked up is repeatedly supplied in numberless flowers during good weather. But in unfavorable weather even a small number will suffer. It is certain, however, that, with a proper management of the bees, the country can not only produce a sufficient amount for its own consumption, but its surplus may also largely enter into the articles of export, adding much to the increase of national wealth and prosperity. Here the question very properly arises whether Nature's stores of honey, which are so rich on this continent, should

be collected, as can be done, with so little means, or whether thousands upon thousands of hundred weights of honey be allowed to be lost. How many colonies might be kept, and what a vast amount of honey and wax might be produced throughout the whole country, may be seen by a glance at its extent, or noting its number of square miles, deducting the barren tracts which are destitute of all bee-food. All the bee-raiser requires is a simple habitation for himself, fencing for his hives, and dogs to secure them from injury by cattle and from thieves. Bees neither require any soil adapted to cultivation nor pasture land, like cattle. Even the so-called waste land, as swamps and rocky tracts, will add to their sustenance, though nothing is grown on such places except swamp-plants, shrubs, or trees. They can do without agriculture and population, the latter not being desirable on account of too much intercourse. The neighborhood of large cities, or a moderate distance with railroad communication, offers the bee-raiser a good market for his honey when yet fresh and not melted, especially in the wax-combs, made in places adapted to its preparation, and obtained by the use of glass vessels or other dishes in the hive. These are never used by the queen for depositing her eggs, but altogether for storing away honey. The vessels required for the management of honey are few—a boiler and some honey-casks—and are not nearly as expensive as the apparatus required for the manufacture of sugar, syrup, or other products. The wax, after melting, requires no packing; it can only be destroyed by fire, and never deteriorates, as is also the case with pure honey.

The second objection, that, on account of their tendency to sting, it is risky and often dangerous to keep bees, is without foundation. The puncture, as is well known, is the wound caused by the sting, and accompanied by swelling. The swelling is the result of an acid similar to that distilled from ant-hills, and contained in a vesicle at the root of the skin, and gradually pouring into the wound. The bees of Germany, it is true, are often quite malicious, but those here in the South are really of a good-natured character. One may manage them for days, may produce artificial swarms, take away their honey—in short, may undertake any operation with them without being stung. But suppose they were even worse than those of Germany, it would not form any really serious objection. To avoid their stings, however, the bees should neither be pressed nor squeezed; they should not be breathed at, nor should there be any pushing against their hives; all fast running in front of their hives and rapid movements of the hands must be avoided. It has been said that bees are irritated by the disagreeable sweat of man, but the writer has never seen it. This would certainly be bad, as the labor required in the management of bees cannot be performed without causing perspiration; especially is this the case with the hiving of the natural swarms during the hottest time of day. A quiet and fearless management of bees is necessary. Smoke is the most effective and never-failing means against their tendency to sting. The old bee-raisers used therefore their earthen smoking pot, sometimes increasing its effect by a small bellows attached to it. It was only by carrying this smoking chimney before them, protecting their hands with gloves, and having the bee-cap over the face, that bee-keepers formerly ventured to approach their bees, performing all operations under this oppressive shield, though they had to perspire profusely under the bee-cap, and could scarcely see through.

Rev. Mr. Dzierzon and his followers entirely banished the bee-cap and glove; instead of the smoking pot, they make use of a burning cigar, or little lighted stick of decayed linden-wood, the smoke of which can be easily blown with the mouth to whatever spot required, and it is enough to blow now and then a little cloud of smoke towards the bees. Where one has no such linden-wood, a bunch of rags is used. The glowing ends of such a lint-stick must be put into the water or buried in the ground after use, so as to avoid any danger of fire. Should any one be stung, the pains of the sting will gradually be less felt, the person having become inoculated, as it were, against the so-called bee-poison. The smoke benumbs the bees. Yet, if enraged by a violent shock, by many being crushed, or by a hive being upset, the strongest smoke will be of no avail, and there remains nothing but sudden flight The Italian bee does not show such rage; she stings only when pressed or irritated in the highest degree. This mild character, not to mention its greater industry, renders the introduction and extension of this race important, as the fear of being stung, though often groundless, deters many from engaging in the enterprise of bee-raising. In the progress of his management the bee-raiser will have acquired so much skill and practice that, even in an extensive bee-stand of 100 hives, he can readily discover and catch every bee disposed to sting him, wherever it may be. He throws it with his hollow hand down to the ground, passing on one step further if he wishes to save its life. Among hundreds of humming voices he becomes able to recognize the voice of that bee, more or less distant, which is disposed to sting. After being stung so completely that the sting, owing to its inverted hook, must remain in, the pain and swelling, especially in new hands, is quite severe. For these evils there is no complete remedy, though there are many ways to soothe them, as, for instance, to crush the body of the bee on the place where one is stung, for it often remains there a few moments; use wet loam or dirt; besmear it with honey, with oil, saliva, sal ammoniac, alcohol, or merely apply rags wet, or water or vinegar. The best course seems to be

to pull out the sting as soon as possible, which, being provided with inverted hooks, remains for the most part in the wound, causing the death of the bee, and to squeeze the wound between the two fingers until a watery drop issues, when the pungent bee-poison, which causes both the pain and the swelling, is also removed. The wound caused by the sting may also be pressed upon the pulp of a pear—an experiment tried by Rev. Mr. Fischer, of Kaaden, Bohemia, who, after being stung by three bees on the point of his finger, immediately took a pear from the next tree, laid open its flesh (or pulp) and pressed his finger against it. His pain almost immediately disappeared without any sign of swelling. It might be inferred from this that other fruits can be used with the same effect.* Nobody could have betrayed more fear than the writer as a new hand, but now he looks upon the sting of bees with indifference, as will every practical bee-keeper; and the subject has been treated with such minuteness only because most persons attach so great an importance to it.

As to the third objection, that to obtain a knowledge of a proper treatment of bees requires too much time and is too difficult, it may be remarked that these difficulties are but imaginary. Many persons are afraid of approaching a bee-hive. They think they cannot hive a swarm or take the surplus honey, &c., looking upon these operations as requiring much skill, while devotedness to the object and courage only are sufficient for the performance of this kind of work. Let the novice first read some good work on bees, (he will soon discover the errors of many books by comparing them with better ones,) observe the manipulations of practical bee-keepers, as well as put up hives himself and manage them fearlessly, and he will in a short time acquire skill to perform everything necessary, often even better than he sees it done by others.

As to the time required for gaining a knowledge of bee-keeping, all operations consume the less time the nearer they approach nature. This is true with the Dzierzon method advocated in this paper. Based upon the natural history of the honey-bee, it implies facility and simplicity in the treatment and habitation of bees. The hives should be as simple and cheap as possible, so as not to reduce the profits of the yield. All artificial and expensive hives should, therefore, be banished, and every bee-keeper be able to make his own hives.

Among the means best adapted to the promotion and general distribution of bee-culture, instruction and practice rank highest. There are already many good bee-manuals, the influence of which, however, should be increased by the establishment of a special journal for bee-culture and model bee-houses. From the importance of bee-culture, in respect to national economy, model bee-stands ought to be put up both by the National and State governments.

Such model bee-stands might be attached to the Agricultural Division of the Patent Office, under the management of a special bee-master. The object of such a model bee-house would be to promote bee-culture, not only by distributing swarms and queens, but by diffusing practical knowledge among the public at large, and generally by serving as a bee-school to teach by practical demonstrations the natural history and habits of the bee, and to show all the operations and manipulations in bee-keeping; for instance, the production of artificial swarms, hiving, taking out honey, &c.

This object might be still further secured in establishments of a similar character by all the State governments, in connexion with the several State agricultural colleges, or other similar institutions. Such establishments, based upon the results and experience of modern investigations and principles laid down by Science herself, and by recognized masters in this branch of industry, should be conducted only by intelligent and practical men, who, by long experience, have become thoroughly acquainted with the progress made in bee-culture and its present condition. To any objections against such model or experimental bee-stands on the ground of expense, it may be replied that they would not only sustain themselves, but, beyond the great object to be attained—the general promotion of bee-culture throughout the country—they would likewise furnish a rich revenue from their products.

In compliance with a request made to him, Dr. Engel, director of the Royal Statistical Bureau of Prussia, has kindly communicated the following statement, showing, in table A, the consumption of wax in the States of the German Zollverein. Honey, not being specially mentioned in the tariff, is included among other objects. The table B shows also the total number of inhabitants and geographical square miles embraced in these German States.

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*A recently discovered and approved homoeopathic remedy is the *Apis Mellifica* taken internally—a few globules at a time.

WAX.

(A.)—*Import, export, and transit in the Zollverein.*

Year.	Import.	Export.	Excess of import.	Transit.
	Quintals.	*Quintals.*	*Quintals.*	*Quintals.*
1848	6,487	343	6,144	209
1849	7,979	1,360	6,619	783
1850	7,351	773	6,578	564
1851	6,400	602	5,798	601
1852	5,476	669	5.476	1,148
1853	6,487	739	6,487	857
1854	4,317	2,915	2,915	520
1855	4,653	1,059	3,594	703
1856	7,061	1,608	5,453	768
1857	5,763	1,039	4,724	688
1858	8,043	1,895	6,148	584
Eleven years.	70,017	13,002	57,015	7,225

(B.)—*Area and number of inhabitants.*

Year.	Geographical square miles.	Number of Inhabitants.	
1846	8,247.54	29,460,816	
1849	8,247.54	29,803,007	
1852	8,247.54	30,492,792	
1855	9,067.85	32,721,094	Hanover and Oldenburg joined.
1858	9,067.85	33,542,467	

Population, according to the Census of December 3, 1858.

States of the Zollverein.	Inhabitants.
I. Kingdom of Prussia	18,107,274
The Grand Duchy of Luxemburg, (not already included)	192,196
II. Kingdom of Bavaria	4,621,279
III. Kingdom of Saxony	2,122,148
IV. Kingdom of Hanover	1,865,104
V. Kingdom of Wirtemberg	1,690,898
VI. Grand Duchy of Baden	1,334,052
VII. Electoral Hesse	699,798
VIII. Grand Duchy of Hesse	862,999
IX. Thüringia	1,043,771
This comprises: 1. A small part of Prussia; 2. Part of Electoral Hesse; 3. Saxony-Weimar; 4. Saxony-Meiningen; 5. Saxony-Altenburg; 6. Saxony-Coburg Gotha; 7. Schwarzburg, Sonderhousen; 8. Schwarzburg Rudolstadt; 9. Reuss, older house; 10. Reuss, younger house; 11. A small part of Bavaria.	
X. Dukedom of Brunswick	249,771
XI. Dukedom of Oldenburg	236,789
XII. Dukedom of Nassau	435,777
XIII. Free town of Frankfort	80,611
Total	33,542,467

As stated above, the import of honey is not specially mentioned in the tariff—imported, as it is, both from East and South of Europe into Germany in an unclarified state, the wax contained in it may be worth, in round numbers, $152,143, while the value of honey may be set down at $785,540. Considering the area, number of population and industry, the value of honey and wax produced in the States of the Zollverein may be estimated, in round numbers, at $10,598,966. The consumption of honey in the Zollverein States would, therefore, amount to $11,536,649. At the same rate in the United States, with probably about the same population at the present time, the amount of honey needed for consumption would be the same, ($11,536,649.) But as there is, perhaps, not more than a fourth as much consumed in the Zollverein States of what would be even a supply at hand, or produced in the country itself, it may safely be assumed that the present population of the United States would consume honey amounting to about $46,146,596, on an annual average of not even $1 50 per head. Its production, however, is much easier in this country than in Europe, owing to the greater quantity of material for it here. Considering the greater number of square miles of the United States, allowing even a deduction of two-thirds for barren lands, and cultivating only 50 hives to a square mile, instead of some hundreds that might be easily sustained, there would be about fifty millions of hives, giving an annual of at least from one hundred to one hundred and fifty millions of dollars. In 1857 the import of sugar and molasses into the United States exceeded their export by forty-eight and a half millions of dollars. A great portion of the sugar still required might, however, be supplied or rendered unnecessary by a large production of honey, while the amount of capital demanded for its import might be obtained by the export of honey. In addition to this, it must be kept in mind that the cost of production is, at least, one-fifth less than that of sugar, if purchased.

On application to the Treasury Department of Austria, the following communication was received by the writer, showing the *exports, imports, and transit* of honey and wax, and the state of bee-culture in the Zollverein or Customs-Union of Austria, from 1849—1859:

Articles.	Years.	IMPORTS.		EXPORTS.		TRANSIT.	
		Customs, quintals.	Value in Austrian florins.	Customs, quintals.	Value in Austrian florins.	Customs, quintals.	Value in Austrian florins.
Honey and honey water.	1849	3,105	34,927	2,234	25,137	311	3,503
	1850	5,164	58,099	2,996	33,705	243	2,709
	1851	5,397	60,719	4,162	46,822	709	7,976
	1852	14,887	182,952	2,308	26,449	115	1,328
	1853	15,558	196,031	2,370	27,373	716	8,270
	1854	11,661	141,014	720	8,316	282	3,257
	1855	25,415	299,797	1,327	15,327	542	6,260
	1856	9,053	107,099	2,183	25,214	....	....
	1857	10,006	119,912	4,888	56,456	....	....
	1858	12,537	157,564	977	11,724	....	....
	1859	5,551	70,364	2,382	28,584	....	....
Wax	1849	2,169	187,624	834	70,507	2,239	209,895
	1850	7,142	604,390	1,837	156,723	3,500	328,125
	1851	3,947	333,322	1,869	157,899	2,605	232,018
	1852	4,746	447,363	1,967	165,490	2,153	180,852
	1853	6,294	594,783	1,337	112,308	2,022	169,848
	1854	5,557	525,136	1,171	98,364	1,843	154,812
	1855	6,004	567,378	823	69,132	2,810	236,040
	1856	8,577	810,526	1,423	119,532	....	....
	1857	5,931	560,385	1,664	139,776	....	....
	1858	6,329	569,610	884	79,560	....	....
	1859	4,216	379,440	1,893	170,370	....	....

Table showing the condition of bee-culture in 1854, *according to the Imperial Statistical Bureau.*

Provinces.	Production.	
	Quintals of honey.	Quintals of wax.
Salzburg	500	50
Upper Austria	1,800	180
Lower Austria	6,200	620
Bukowina	3,900	390
Hungary	90,000	9,000
Tyrol	10,800	1,080
Silesia	3,500	350
Dalmatia	9,100	910
Venice	18,700	187
Military Frontier	32,300	3,230
Bohemia	41,300	4,130
Moravia	21,200	2,120
Transylvania	50,600	5,060
Croatia	19,200	1,920
Gorz	9,000	900
Galicia	85.400	8,540
Lombardy	19,400	1,940
Serbian Banat	39,600	3,960
Carinthia	15,000	1,500
Styria	39,000	3,900
Carniola	31,000	3,120
Total	547,700	54,770

Total value, 8,763,200 florins, or about $4,381,000, in a country numbering 34,500,000 inhabitants, and 11,240 Austrian square miles; its population and area being about equal to that of the Customs' Union of Germany.

As it is well known, however, that the statements of the producers are always lower than the actual production, for the purpose, in a measure, of evading taxation; as it is further known that such honey only has a place which enters into commerce, excluding the home consumption of the bee-keepers themselves, four out of every five consuming their own production, a surplus product of at least $10,169,000 must be set down, so that Austria annually realizes from bee-culture $15,000,000.

Table showing the distribution and number of hives, also the amount of honey and wax in the different portions of the empire.

Crown lands.	Total number of bee-hives.	Number of bee-hives to one square mile. Bee-hives.	Quintals of honey.	Cwts. of wax.	Value in florins.
Salzburg	2,000	20	5	0.5	70
Upper Austria	9,000	50	9	1	175
Lower Austria	31,000	100	20	2	350
Bukowina	19,000	140	29	3	490
Hungary	450,000	160	31	3.1	560
Tyrol	54,000	180	36	3.6	630
Silesia	17,000	200	41	4.1	700
Dalmatia	45,000	210	42	4 2	735
Venice	93,000	220	54	5.4	770
Military Frontier	161,000	250	55	5.5	805
Bohemia	206,000	260	60	6	910
Moravia	100,000	270	62	6.2	945
Transylvania	253,000	300	64	6.4	1050
Croatia	96,000	320	66	6.6	1120
Gorz	45,000	340	70	7	1190
Galicia	427,000	350	72	7.2	1225
Lombardy	97,000	360	73	7.3	1260
Serbian Banat	198,000	400	85	8.5	1400
Carinthia	....	500	94	9.4	1750
Styria	199,000	510	111	11	1785
Carniola	156,000	900	190	19	3150
Total of the averages	2,733,000	270	58	5.8	945

Enemies of Bees.—There are many enemies to bees, some devouring their honey, others the bees themselves. Foremost among these is the bee-moth. Though it is found everywhere, it is most injurious in hot climates. In itself there is no danger of this moth getting into the hive through the fly-hole and other openings and cracks; it does so only when there is dirt and filth. Cleanliness, therefore, constitutes the only remedy. It is true that some larvae of this moth are occasionally found between the wood of the hive and the board upon which the hive stands, and sometimes even on the inside of the cover, especially when made of straw. But damage is not done in this way. The floor of the bee-hive is the place where they are mostly generated. It is, therefore, absolutely necessary that the dust and waste or offal from the formation of the wax should be immediately removed. If there are many bees in the hive they usually clean their hives themselves; but feeble swarms or reduced colonies, especially if their structure of wax is at some distance from the floor, will permit this offal to remain there. The hive should, therefore, be examined every eight days, and all extraneous matter swept off by means of a feather duster. In case the hive has no floor, the standing board must be brushed off.

Ants are also occasionally discovered in bee-hives, though the writer has never noticed any damage done by them. At one time the upper empty honey space was discovered to be filled with many ants and a mass of their eggs, and by sweeping it twice the hive was rid of the intruders. At another time a populous colony of ants had settled between the honeycombs—how long is not known, as neither case occurred in the writer's own hives. But even in the second instance the honeycombs did not show any signs of having suffered by the ants. To keep them off, however, a frequent sprinkling with ashes may be used. There is a large kind of red ants now making their appearance in Texas, damaging with their sharp teeth trees, vegetables, and cereals. In New Braunfels a resort is had to poisoning them.

Of birds there are so few in Texas that they do no injury. Should they prove injurious in other parts of the country by snatching up the bees in the neighborhood of their stand,

they should be shot or caught in cages or traps. Titmice and woodpeckers are the most annoying, because they disturb the bees in their winter's rest by picking about the fly-hole and devouring any that make their appearance.

Mice do not commit any injury in the South, neither in the North during summer, but they may do so there in winter. To prevent them from creeping into the hives and disturbing the bees in their conglomerate state, gnawing the structure, consuming the honey, defiling the hive, they should be kept out by making the fly-hole as narrow as possible by applying a slider, driving in nails, or dividing a fly-hole into two or three smaller holes.

Toads, frogs, lizards, and snakes consume many bees falling to the ground, and snatch them even from the fly-hole when too near the ground.

Among insects, hornets and the so-called fly-wolf (*Fliegenwolf*) destroy many bees, snatching them both from flowers and hives, especially towards the fall, when they have become more numerous and their food is growing scarce. Spiders also catch bees in their nets, and especially in the fall they shut up many flowers, by spinning webs over them, and keep the bees from entering.

Most of the bees which are lost are so by the injurious effects of temperature, by violent and cold winds, sudden showers, especially snow, if they are disturbed in their winter's rest by the rays of the sun falling upon the fly-hole and tempted to fly out. It is well, therefore, to strew ashes over the snow, and keep the rays of the sun as much as possible from the hives.

Another injury arises from the inclination of bees to commit mutual depredations, or to steal their honey from each other. This is a great evil in many places, often resulting in the destruction of entire beestands. The cause was formerly attributed solely to the robbing bees themselves, and every such hive containing robbers was removed to a great distance. A remedy sometimes employed by bee-keepers of using poison for the robbing hive, thus killing not only the actual robbers, but all those remaining in the hive, brood and queen, and often several hives, is wholly objectionable. Even if the robbed hive, in which this poison is placed, is shut up, the rest of the hives cannot be conveniently kept closed, the bees breaking out in some way or another, and, smelling the honey mixed with the poison, will eat of it and die. It therefore becomes a matter of self-interest to avoid the application of so injudicious, desperate, and cruel a remedy, the more so as (according to Mr. Dzierzon) bees are made robbers by the neglect of the bee-keeper himself. If they otherwise have plenty of food, the bees will never turn robbers. But if, especially in spring and fall, or at the South in summer, they have scanty food, bees make all possible efforts to find honey, even if compelled to rob other hives of it at the risk of their lives. The following reasons especially cause them to become robbers:

1. Leaving honey, at the time of taking it out, scattered about, or allowing the honey-combs containing still a little honey to lie around for the bees to lick them. If possible, the honey should be taken out early in the morning, before the bees leave their hives, which can easily be done at the North.
2. Letting hives without queens or weak hives remain too long on the stand. Such hives should not be suffered to remain on the stand at all, as they are first attacked because too weak to defend themselves.
3. Too many or too large fly-holes.

A bee-raiser from the North would be astonished to see bee-hives in this section of the country left entirely open, put merely upon nails or plugs driven in below. An open space of about one inch in height all around the hive is thus left, through which hundreds of robbers can pass in, as they sometimes do, though but rarely. If this space is left for the purpose of ventilation and cooling, it is superfluous, because the bees in all countries lay themselves before their hives for the same purpose. In robbing a hive, only a few bees at first make their appearance, moving shyly around the fly-hole, until they succeed in eluding the sentinel bees (populous hives never neglect to keep watch) and intruding into the hive. Returned with a load of honey into their own hives, many other bees now go out with them; and soon they appear with almost an irresistible impetuosity, carrying off the honey from early in the morning till late in the evening, until the whole hive has been entirely ransacked and the queen killed. By this activity in carrying off the honey, as well as killing each other, they may be known to the new hand to be robbers. The surviving bees at last join the robbers and go off with them. There is no particular kind of bees called robbers, nor can any one teach his bees to enter other hives, as many suppose. Yet, by its repetition, this vicious passion becomes to many a hive a second nature, from which they do not desist until the whole generation has been extirpated.

Among various remedies which have proved successful, where the robbery has not been carried too far, are the following:

1. To make a great smoke, and for hours, in front of the hive robbed.
2. To fasten before the fly-hole a card, a piece of leather, cloth, or something of the kind, but so that it will not prevent the bees of the hive from passing out and in.

3. To remove the hive attacked, somewhat from its former place; not too far, however, lest the bees in it may lose the entrance.

4. To make the fly-hole so narrow that two bees cannot creep through at once. This is among the best remedies.

5. To rub about the fly-hole strong-smelling substances, as wormwood, garlic, onions, &c.

6. To remove the robber hive completely from its range of flight, not less than two miles, will certainly prove effectual, if the robbery is but from one hive. Sometimes it will answer to remove it to only a little distance.

It has also been found useful to throw a handful of shavings in the hive of the robbers. The necessity of getting them out again makes the robbers so much work that they altogether forget to rob other hives.

Robbers coming most frequently from other places may be recognized, as above stated, by their continuing to carry in so much honey. Flour may also be strewn upon them when they are engaged in robbing, and thus they will be recognized on their return, the most intrusive being bees of other stands. On the whole, it is much easier to prevent the evil than to cure it, as it is one of the greatest in bee-keeping, and may cause heavy losses, and so deter many from engaging in this branch of business.

Diseases.—Among these the brood-rot is the most prominent. This is not so much a disease in full-grown bees as a rotting and dying of the larvae and chrysalides that are contained in the covered cells. The interior of the cells sink in, their covers appearing black, and the whole emitting a bad smell. Thus not only is the brood and its progeny lost, the cells defiled and made unfit for use, but the disease gradually spreading, and, at a certain stage, becoming contagious and malignant, sound hives are affected, so that entire stands of whole districts may be ruined, if the evil is not properly remedied. This disease may be known by a certain bad odor issuing from the hive; or if, on a close examination, the brood is found to be not wholly closed up, a few cells only here and there being covered, sunk in rather than convex, with a blackish-brown mucilaginous substance inside, instead of a white larva or chrysalis, we may be certain that the stock is suffering from the evil. If it occurs late in summer, or in autumn, the surest remedy is to break up the hive at once, perhaps kill the bees by means of sulphur. The honey, which may be used as well as other honey for domestic purposes, must be carefully removed from the hive, so as not to give other bees a chance to eat of it. The empty hive, too, requires a thorough cleansing; it must be opened and exposed to the air for two years before being used again. Should the disease make its appearance in spring, when the bees begin to swarm, and if the hive affected is still populous, an attempt may be made to obtain from it one or two younger swarms. These, however, must always be placed in new hives, though not immediately after swarming, as they will carry the infection with them. It is therefore best to put them, immediately after swarming, into a suitable vessel for some forty-eight hours, and then transfer them into the new hives made for them.

There is another kind of the brood-rot of a less malignant character. It appears in the cold and temperate zones, when the bees, induced by the fine weather, come forth too early, the queen also depositing many eggs. The weather becoming cold again, the bees are compelled to retire once more into their former state, deserting the young brood, which perish in their cells and turn foul. The combs thus containing this frozen brood must also be cut away. In all cases the best remedy is to break up the hives attacked by the disease.

More complaint is made by bee-keepers of a disease called the dysentery, which, indeed, strictly speaking, is no disease at all, but merely an inability to retain their excrements until they go abroad, when they drop them on their flight. Instead, therefore, of thus discharging them, they first deposit their excrements upon the outside of the hive, then around the fly-hole, the inside walls, and at last soil their cells and each other. This evil often occurs in long and severe winters, while in countries that have no winter, or a short one, it is not known. Small colonies obliged to consume more in order to generate the heat needed are more exposed to it, especially if late in autumn liquid honey is given them, which left uncovered is liable to attract moisture, becomes sour, and thus is freely eaten by the bees.

The honey collected from the fir and pine, and especially from the so-called honey-dew is more apt to cause dysentery than that from flowers; frequent disturbances also cause it, requiring a greater consumption of honey. If the bees possess a warm hive with a sufficient quantity of honey collected by themselves, and covered, they will rarely, or but slightly suffer, and after going abroad a few times recover, when the bad smell will also disappear; while those which in autumn have to be fed either with thin honey or sugar, and have cold hives, especially young colonies, very often suffer. When they go abroad for the purpose of cleaning themselves, they may be aided by feeding them with thin honey in a lukewarm state, or dissolved sugar. Previous to such excursions hardly any remedy can be applied; but should they not succeed in cleaning themselves in hives with movable combs, the soiled combs must be cleansed with a soft brush and water, dried, and put in again, or, which is easily done in such hives, exchanged for clean combs. The dirtiest combs may

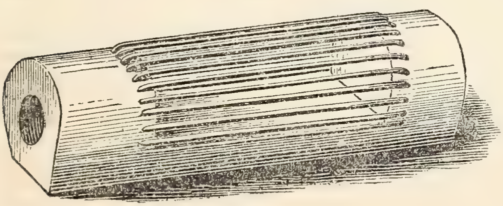
also be cut out, leaving only a small portion in the middle; and should the colony thus be in want of a few clean combs filled with eggs and honey to regain strength, by using the movable comb hive they may be easily put in. The hives themselves, that is the fly-holes, walls, and floor, should be scraped clean, washed out, or, if they are simple hives, be exchanged for clean ones.

Want of a Queen.—Most hives perish in consequence of having lost their queens. This occurs when the queen dies or is missing in autumn or winter, when a young queen cannot be raised for want of a brood; or (even if one could be so) she cannot be fecundated for want of drones, and the unfit state of the weather. A queen may also be lost in swarming, by getting astray while abroad for fecundation, by falling to the ground on account of her defective wings, or from some other accident. By adding a young brood fit for hatching a queen, or better still a young queen, the hive may be restored if it be yet populous enough; otherwise it is best to break it up altogether before other bees begin to rob it. The difficulty is greater to cure a hive where the queen is unfit—either wholly unproductive or merely laying drone-eggs. In this case she must be taken out and the hive treated without a queen. The brood of drones deposited by such a queen is usually found in worker-cells, that have a highly arched cover. But if deposited by a productive worker, it is usually found in drone-cells, should such be in the hive. If the bees in such a hive look upon this queen as their real one, and have already become accustomed to her, they dislike to accept of even a productive queen, and the cure becomes difficult; because it is so, (or even impossible,) to remove her, as she cannot be distinguished from the other bees.

The want of a queen most frequently occurs when many swarms make their appearance.

If the bees cannot form a new queen, such material—eggs and young worms, usually close together—must be transferred from a perfect hive into the defective one. In the kind of hive described this is easily done, by merely hanging a suitable comb taken from another hive in the middle of the one without a queen; in hives that are not so adapted, a hole as wide as the first must be cut in the brooding-nest, so as to put in the young brood. This hanging in a young brood must be repeated several times, care being taken not to delay the operation too long, or the attempt to cure the hive will be ineffectual, as then the bees may adopt for their queen a worker, that is, a female bee not fully developed, which, as elsewhere shown, lays but unfecundated eggs in the drone-cells. If one of the hives contains queen-cells already filled with eggs or worms, it is best to insert such a queen-cell within a circle of at least four inches in diameter. This queen-egg or worm will always be accepted. If there are queens on hand needed for the restoration of a queenless hive, they can best be removed in the Dzierzon hive, especially from small hives of but one thousand cubic inches capacity. It may happen, however, that the bees without a queen will endeavor to kill a queen so transferred, especially if she is a young queen, not yet fecundated. She must, therefore, be placed in a little cage and thus be put right in the middle of the hive for a few hours, so as to make her known to them. The queen, thus imbued with the smell of the hive, may be taken from her little cage and allowed to pass into the middle of the hive, but not through the fly-hole. A new queen will be most acceptable and even welcome to the workers, when she is offered at the moment they become aware of the loss of their former one, and when still feeling their distressed state. If at this juncture a new queen is added, the bees will at once become quiet and silent.

Fig. 3.



The queen's cage (fig. 3) is best made of a thick and hollow branch of holly. It is from three to four inches long and three-quarters of an inch in diameter and well rounded. The middle portion, three-quarters of an inch from each end, is cut out to the depth of one-half of the diameter, and the half of the edge thus cut off is latticed by inserting, lengthwise, wires so near to each other as not to allow a bee to pass through. In the middle, at one end, there is a round hole, made lengthwise, about one-half of an inch wide, for putting the queen in the cage, after which this hole must be closed with a stopper. The back of the cage is not rounded, but cut smooth throughout its whole length, so as to make the cage stand. Should the other bees at first show a hostile disposition against the queen in the cage she retires, but they very soon caress each other, they giving her food. Even if there should already be another queen in the hive, still some good-natured bees feed the queen thus given them. If care is taken to let the queen's cage always remain in the brooding nest—that is, at the place where the bees seat themselves—queens may thus always be kept on hand for the purpose of relieving a colony without a queen. A queen may also be secured

for this purpose by keeping a mother-bee in the upper and warm room of the hive, entirely separated from the rest and sufficiently provided with honey, and giving her about 1,000 bees, for which, of course, a fly-hole must be provided.

The following are the signs by which a hive without a queen is known:

1. The gradual decrease of the number of bees. 2. They spare the lives of the drones longer than other colonies. 3. Discouragement. 4. Sometimes they evince a greater tendency to sting, in order to keep away the robbers which threaten them. 5. They almost entirely neglect to gather pollen. If there is a plenty of food in the flower they will store their hive full of honey. The rich pasture is then also one of the causes why the hives without queens are spared by the robbers. An attack by the robbers is more frequent where there is a small collection of honey. As a sound brood and eggs is the only sure mark of the health of a hive, this fact must be ascertained. All colonies from which swarms issue, either natural or artificial, must be examined, twenty or thirty days after swarming, should they present some of the above suspicious signs. Until a hive without a queen has been either fully restored or broken up the entrance of its fly-hole must be made very narrow.

Propagation.—A hive annually receives a young queen in a natural way, in consequence of the old queen's leaving it, with a great portion of the colony, to commence a new household in another habitation. This is called the early or primary swarm. In the old mother-hive thus left there is now no queen fully developed, only queen-cells, built by the bees under the influence of the increasing heat, and in anticipation of a necessary future separation. The queen-cells there at this juncture contain queen-worms just at the stage of their transformation into royal chrysalides. About nine days after the departure of the early swarm the young queens, three to twenty, and sometimes even more, begin life in their cells. They announce their presence by uttering a clear shrill tone, something like "teet," "teet," while the other young queens still in their cells usually respond by a sound like "off," "off." The young queen that was the first to leave her cell, now, from fear of the other queen-cells, quits the hive with a portion of the bees left after the departure of the old queen, also reinforced by a number of bees that have just left their cells. This is called the "after-swarm;" and should the young queens continue to call, may usually be followed every other day by a second, third, and even fourth after-swarm, their respective queens being alike in their fear of the rest of the queen-cells. In the after-swarms there are often several queens, all of which, as in the parent hive, are killed, except one. Sometimes the queens, from jealousy, kill each other, sometimes they are destroyed by the workers. Queen-cells, also, if any remain, are bit open. This is usually begun by the queen herself, to whom the other bees have already paid their homage. The young queen, having thus become monarch of the hive, now goes abroad for impregnation, and begins to lay eggs two days after it has taken place. A populous swarm, especially an early or primary one already having a fecundated queen, will, during favorable weather, fill a moderate sized hive in a short time, and may, in the course of a month, become so numerous as to swarm again. Such a swarm, issuing from a swarm of the same year, is called a "virgin swarm." A swarm is often caused, even at an unusual time, by the fecundated old queen being accidentally missed or removed; fourteen days after the young queen which has first emerged from her cell departs with a portion of the colony from the hive, leaving the same in the possession of one of her younger rivals. Such a swarm is called "teet-swarm," because it is usually announced a day previous, like the after-swarms among the young queens, by the peculiar call of the mother. Sometimes the whole colony leaves its hive as a swarm. In the fall this is usually on account of hunger; in the spring other causes are at work, as the coolness of the hive, uncleanliness, moths, etc. Such swarms are called "hunger-swarms," "distress-swarms," or "beggar-swarms." They do not, at first, hang themselves on any object, as a tree, for instance, like other swarms, but directly seize on other hives, from which, however, they are generally driven away by the stings of the occupants. Even at the time of swarming a colony may leave a hive which it has taken into possession and partly built up. This may be on account of excessive heat, too great exposure to the rays of the sun, or want of room in the hive itself. The natural and usual way for the bees is to separate of their own accord, a hive, or colony, issuing forth or sending off from one to four swarms as new colonies. As propagation is of advantage only when there is plenty of food for the young, and since a good supply is required to sustain three or four young swarms, all beyond this number should be avoided as not advantageous. Artificial feeding in summer is not advisable, though it may sometimes be practiced at the North.

As to the signs of swarming nothing is known with certainty, the new swarms sometimes breaking forth beyond all expectation. The completion of a hive—that is, its being stored with filled honeycomb, together with a numerous colony, usually leads us to expect a swarm, while at the same time it often takes place in a hive still incomplete, and with only a moderate sized colony. When the bees hang about the outside of their hives, especially at night, it is also regarded as an indication of swarming; but others likewise hang about that

do not intend to swarm, driven from their hives merely by great heat. Though the swarms do not commonly issue forth before the drones appear, yet occasionally a swarm does so. This, however, is but a singing or a calling swarm, being the first or early swarm with the young queen, the old queen having disappeared. The young queens only utter this calling tone in the hive before swarming; it may easily be heard by holding the ear, late in the evening or early in the morning, close to such hives as have already produced swarms. By this sound, which seems to be a call to the bees to gather round the queen, we may know, if the colony is strong enough, whether after or secondary swarms can be still expected. The question whether swarms will make their appearance, and, if so, when, may be answered by searching out queen-cells containing the queen-egg or the queen worm; but these are rarely found, and even if hives open below are placed at the top for more convenient examination, it is still difficult to discover them.

The Dzierzon hive affords a better opportunity, as the combs can be taken out and examined. Yet the day and hour for their breaking forth are always uncertain; even the first after swarm, which succeeds the departure of the early or primary one, varies in the time of its appeanance, according to circumstances and weather, from the fourth to the thirteenth day, though it frequently comes forth on the ninth day. The third swarms appear within two or three days after, and the fourth on the same day following. In localities where the bees cannot find sufficient food, it is advisable to return the fourth, often the third, and sometimes even the second swarm to the present hive, or to assign from two to three swarms to one hive, or to cure a sickly or weak parent hive by the addition of a young swarm.

The attempts to unite several colonies, and prevent one of them from leaving the hive and flying off, should not be undertaken before sunset. Until then, let them be kept in separate boxes or vessels, and sprinkled over with honey-water.

If in any hive drones are found in the worker-cells, or the queen neither lays fecundated eggs, or her seed vessel has become so weak that she lays but a few good eggs and many bad ones, such a queen must be caught and killed, or she will kill the new and better queen. Should the defective queen not be of the royal shape, she cannot be recognized, and can be caught only with great difficulty. In this case, and especially if the new queen has been stung to death, no more time should be wasted in the cure. It is best to clear out the hive and save the honey, or to kill all the bees of the hive, and put a new colony in the combs when they are of fair promise.

The same uncertainty in regard to the appearance of the swarms, especially the early or primary swarms, belongs also to the discovery of the places selected by them. After leaving their hive they usually suspend themselves to a neighboring tree branch or shrub for half an hour or several hours, and they will sometimes thus remain until the next day. But often they stay only for a short time in the neighborhood, or start immediately for some unknown distance. They frequently fly to some secret place near by, especially when it is overgrown with trees, which makes it difficult to detect them. Jingling with scythes, sickles, little bells, and other noisy things, as well as shooting into the swarming colony in order to make them stay and settle down, is of no avail. In examining the hives an experienced person will, it is true, recognize by the weakened flight of a colony but few in number the hive which has sent forth the swarm, but he cannot discover it when settled any better than a new hand. To induce the bees to settle near by, erect a tree if there is none there; let the vessel for receiving and carrying the swarm into its new home remain suspended during the time of swarming; also put up a second one at some other suitable place as, for instance, where swarms have been before taken up. Sometimes they will enter them of their own accord. In Germany they are often taken up by means of a sieve, about twenty-four inches wide, with a cross band above for holding and carrying it. If possible, fasten the sieve with an iron hook below the swarm, and shake them in it with a jerk; but if they are attached to a thick trunk, it is better to brush them in gently with a duster. After this the vessel with the swarm should remain on the spot for a few minutes, so as to give those that are still flying about an opportunity to join the others. Another cluster of bees often collects at the place where the swarm was suspended, either soon after it has been brushed off, or even after it has been placed in its new hive. These clusters must be hived as they occur, because the queen may be among them. Light, wide, and shallow baskets of straw may be used for hiving. The following contrivance is also useful for the same purpose. Sew a hoop of a flour barrel on the top of a bag of six to eight inches deep and as wide as the hoop. A band to carry it by should likewise be sewn across the top. Should the swarm be attached to the branch of a big tree, not strong enough to hold the weight of a man, this swarming bag may be raised on a pole under them, and the swarm thrust into the bag. By means of such a catch-net, sieve, or basket, the swarms, if necessary, may be carried uncovered for two miles without the bees flying off. If they are shut up while so carried, they often perish, because they heat themselves so much in hot weather that they are obliged to disgorge the honey which they were carrying into their new hive. Hence they besmear each other so much with honey that they must perish. One hive at least ought to be kept ready

for putting in the new swarm, and in this there should not be the slightest delay. If the hive is ready, placed at its future stand, its inside cleaned, and (should it be a Dzierzon hive) the comb-holders are all in order, and the honey rooms entirely closed, thèn, if it stands on the ground, turn the hive, and should there not be room enough in the rear for easily putting them in, and its future stand be on an elevated fly-board, put it upon a convenient spot on the ground. All this handling of the hive, securing the bees, and then placing it on the fly-board, should be performed cautiously and gently, so as not to move from their places the loose pieces of comb put in to encourage and induce the bees to begin their work immediately. Put also directly before the hive a broad board or cloth so that they can creep in with greater ease. Some bee-keepers use a "bee-course," that is, a board wide at the hind part and narrower at the front; its point reaching into any hive desired. It should have a border on its side and back edges of from one to two inches high, and four holes for putting in feet. It should be set before the hive, sloping towards it; the back being a little higher than its fore part. If the hive does not stand on the ground, the "bee-course" must have feet long enough to reach it. The swarm, immediately before it is put into its new hive, must be a little fumigated and sprinkled with water. Then mount the ladder fearlessly, with open face and uncovered hands. In this country the writer has never been stung during this operation, though hundreds of bees were tumbling and crawling over his hands, and even seating themselves in his face. In this case they suffer a man's breath without becoming irritated. Neither was he stung more than twice in Germany during all his handling and hiving swarms; once, when a novice, holding a sieve beneath a swarm shaken off a tree during windy weather, which irritates the bees very much; at another time upon a tree, where he probably squeezed a bee. There must be no wavering, however, as to drop the sieve or swarming bag would be much worse. Having brought the swarm to its future hive, the greater portion should be scraped with a large spoon or a little plate out of the swarming bag upon the floor of the hive. This should be done gently, so as not to injure the queen. After being put in the hive, the swarm will immediately begin a cheerful humming, rejoicing at its new habitation. This humming will attract and induce the remainder of the bees in the swarming bag to enter the hive of their own accord, or they may be rapidly at once shaken in. Those below and at the outside walls of the hive should be forced in by means of smoke, and those that linger about the opening or door gently brushed in, so as not to be squeezed on shutting the door; and then if the hive is not already there, remove it to its proper place. When this is done, the bees will immediately go to work, flying out and gathering honey. Should the hive be open below, or made of straw, turn it on its side; and after the bees are put in, close the opening by pressing a board upon it to keep the bees from dropping out when the hive is put up.

Great trouble is experienced by bee-keepers of all countries from the breaking forth again of swarms already hived. This occurs in temperate zones during hot summers only, while in Southern countries it always takes place. Be careful not to overlook such an occurrence, as the swarm might start for parts unknown. The best course to pursue is to hive it as often as it leaves, for the swarm will sooner give up breaking forth than a person should in hiving it. To remedy this evil—

1. Render the hive as cool as possible by means of shade. 2. Wet it, or, still better, cover it with a cloth always kept moist. 3. Rub the inside with some plant of a pleasant odor, or, better yet, with honey. 4. Place in the hive honeycombs, or rather brood-combs. 5. A still better remedy against the flying off of natural and artificial swarms is to cut the wings of the queens. In doing this the swarms should be freely sprinkled with water, that they may not fly off as soon as search is made for the queen. In the case of young queens, and so in all after swarms, it can only be done after they have begun to lay eggs. Even should the bees fly off, they must still return to the queen left in the hive. Yet every time they go abroad, either for swarming or otherwise, where there is a queen with her wings cut she must be looked after, as she usually falls to the ground. If several swarms of the same kind (either primary or after swarms) happen to be united in one mass, it is best to put them all at once into one or at most two hives, without undertaking to separate them, leaving this to themselves. As soon as the queens fear for their lives, the most timid one leaves the hive with her party, after which this latter swarm must be separately hived. Even should this voluntary separation not take place, and one of the queens be killed, yet no damage is ever experienced from populous hives during the time of swarming.

As hives that have produced swarms, natural or artificial, must send out their queens for fecundation, they should not be put closely between the other hives. If practicable, place them for the next two weeks a little ahead of the others, and fasten above the fly-hole a distinct mark, as a little green branch, or a small bit of rag of some glaring color, by which the queen can easily recognize her hive. This may also be done with those hives in which, after swarms are put, yet the young queen in most cases meets a drone while swarming. If the earlier or primary swarm should leave a queen weakened from age and with defective wings, frequently she will fall to the ground in the attempt to swarm. In this case she is

often noticed by some of the workers, who immediately surround her. She must then be taken up and placed in the new hive, or be added to the swarm wherever it has settled, unless it cannot be hived immediately, otherwise the swarm will return to its parent hive. The observation of the process of swarming is a matter of high interest to any one having bees, as well as to the practical bee-master, who will especially notice the departure of the queen as it takes place at different periods, sometimes sooner, sometimes later.

Artificial swarms.—The question has often been asked, "Shall there be artificial swarms or not? Those who are opposed to it say that they are of no value, and contend that they are sometimes formed too soon, at others too late; that sometimes the parent and sometimes the artificial hive becomes too weak, &c.

As to this question, artificial division should never be practiced at the expense of reducing the strength of the hive. The parent hive must, at all events, retain bees enough both for its brood and household, while the new hive must have a number sufficient for building their combs. Should the place and the year be rich enough to produce as many natural swarms as are needed, every bee-keeper will be glad to save himself the labor of raising artificial swarms. The artificial swarm is often exposed to bad weather and want of food. In the South this is not of much importance, but in the North the bee-keeper must provide the hive with a few combs of honey if necessary. Even natural swarms, though endowed with a certain instinct of foreseeing the weather, are sometimes exposed to this double failure, and also require to be fed. In producing a natural swarm there will certainly be a proper division of the bees; but the bee-raiser himself, living in the neighborhood of his bees, has it completely in his power to make an equal and appropriate division. He can for eight days somewhat change the places of the hives, or put partition boards in between the hives, as up to this time no bees of the two hives are killed by mutual attacks. This should be done early, while the populous colony is able to stand it, but a weak colony may be spared until it becomes more populous. The period when there is the greatest quantity of nourishment must decide when artificial swarms can be formed most profitably, so that in many localities, especially where the heath grows, swarms are produced in fall which will turn out perfectly good, though all admit the best time for swarming everywhere is the first part of summer. Voluntary or natural swarms, too, will soon settle and begin their work, gathering honey and building cells, but artificial swarms commonly do so before half the day is over. As there are localities where swarms are sent out either seldom or too late, though they find nourishment enough, prudence requires a resort to the useful method of artificial propagation. Again, where there is only a small number of hives it will not repay the cost to keep a person specially to watch for the appearance of the swarms, as they will frequently escape, however great be his care and attention.

Among the different methods adopted in forming artificial swarms, the most practical seems to be to drive out one-half (perhaps even more) of the bees, including the old queen. The number kept back in the parent hive is steadily re-enforced for the next fortnight by young bees daily emerging from their cells, there being only a cessation of from seven to ten days until the young queen raised shall have deposited a new supply of eggs. This remainder of the colony being still supplied with honey and pollen, will after one month be as strong again as it was before the other half was driven out.

On the other hand, the artificial swarm, when formed early in the season, will be as strong as a primary swarm, everywhere thriving well and distinguished by extraordinary industry. There is one evil, however, which should be mentioned: the artificial swarms made in Texas frequently leave their hives again. This fact is the more striking, as in Germany, when properly formed, and having, of course, their own queen, not one among fifty of artificial swarms will again leave its new hives; and this is probably the case also in the Northern portions of this country. They must, therefore, be hived as often as they leave their hives, and should be closely observed during the first three or four days.

In forcing an artificial swarm we proceed in the following manner: The new hive being ready to receive the swarm, a small box is made open below, and having the same circumference as the hive itself. Should the hive consist of four-sided boxes, this little box must be made of the same shape, and put upon the top, so that the side below left open accurately fits the opening of the hive when placed upside down. This little box on top must be made round in case the hive is a round straw hive, or some other of rounded shape. It must be borne in mind that the hive is to be turned upside down, opening upwards, before this little box or receiving one is placed upon it. This top box should be well fitted to the edge of the hive, so that, after the fly-hole has been closed, no bees can escape. Yet, though some, by chance, might escape, not many will try to do it; and even should any get out, they are timid, and not disposed to sting. The others flying about are much more so. At the beginning of this operation, in lifting, turning, or opening the hive, smoke must be freely blown at them, for this is necessary in all the management, and in even the most trifling parts of it. Though in the progress of the different operations a lighted match should always be on hand, there may be very little occasion to use it. The top box being

put upon the hive opening upwards, take a few sticks and drum against the lower part of the hive until bees enough have passed into the top box. By applying the ear to its top we may judge from the humming of the bees as to the number that have already gone into it; or a pane of glass may be inserted in one side of the top to enable the bee-keeper to watch the number of bees that pass into the top. The top may also be examined by occasionally lifting it a little at one side. If some smoke can be let into the hive from below, the bees will ascend more rapidly. If this driving out of a larger part of the colony is done at the usual stand of the hive, open the fly-hole from time to time to allow the bees returning home to enter their hive. But in case the hive has previously been removed to some more convenient and shady stand, put up a similar empty hive in its former place for the returning bees to fly into. After a sufficient quantity of bees have passed into the upper box let it be removed. In Germany it is placed upon a black cloth, or a dark sheet of paper, to ascertain whether the queen has passed into the top, in which case she will soon have dropped several eggs upon the cloth or sheet of paper spread below. For the same purpose something black may be spread upon the floor of the new hive. Then transfer the artificial swarm from its box into the hive destined to receive it, and which has been provided with a honeycomb. It should be transferred in the manner described for transfering natural swarms. If this artificial swarm does not contain bees enough, they may be anew driven out; but if it has no queen, the operation must be repeated, otherwise the bees will leave their hive in half an hour to two hours, and return to their old hive.

Should the hive from which a swarm is formed by driving them out be a round straw hive, the top put on it should likewise be round and made of straw. In the Dzierzon hive this operation can only be carried out where the hive is a large one, and there is empty space enough left in the lower part, or when the space for honey remains still unfilled. After this hive has been turned upside down, the bees driven up are transferred into their new hive by means of a ladle. If the object be to make them pass into the empty honey-room above, it is not necessary to turn the hive; but then a smaller box may be shoved in, of course with its opening down, so as to induce the bees to enter it. The Dzierzon hive is better adapted to this method of artificial propagation, as the larger half of the brood and honeycombs can be transferred from the old hive into the new one.

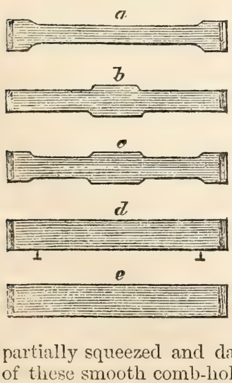
The queen usually remains in the old hive with the rest of the bees, yet it should be ascertained whether she is not among the combs transferred; if so, the artificial swarm requires three or four times less honey and brood. The adoption of this method of division makes it necessary to remove, as far as is possible, the hive containing the queen. Whenever the transferred combs contain less bees than are required for covering and nursing the brood-combs, the old hive may be brought to quite a different place for from one to four hours at the time the bees are flying out, and the newly-made artificial swarm may be substituted for it, so that the necessary number of bees will fly in. But if the queen in the other hive has been properly driven out, place the new hive alongside the old, assigning to each half the space formerly occupied by the old one, provided both hives are of the same appearance; otherwise give as much room as possible to the new hive. If necessary the proper distribution of bees may be regulated by a partition board set up between the two hives. Later, even some eight days or so, it may be changed.

As has been already shown, an artificial swarm may also be produced, even without turning the hive upside down. The workers, like the queen, will yet ascend, though a little slower, as the passages between the combs are rather small. This method may be used in heavy hives, or those in which the combs may be likely to break down from the hive being filled up, or nearly so, with honey and brood, or because they have only new combs, and but few or weak wooden supports. In this case the top must be opened, which can also be done in the Dzierzon hive. There is no difficulty in forming an artificial swarm by driving the greater portion of the bees out of the hive, as many believe. Others, again, prefer driving the bees into an upper box, open in the rear, in order to see the queen when ascending; but she likes to hide herself behind the workers, so that they often fail in their object; and, even in case they attain it, they will not be compensated for the disadvantages attending the means used. Though the driving of them out may be done at any time of the day, the afternoon seems to be the most suitable, because they are then somewhat tired after going abroad. But care should be taken to get through before dark, for the bees are peaceable only in the day time. At night they are in an angry mood, so that almost every bee that comes in contact with man is ready to sting. Early in the morning the artificial swarm will hurry back to the old hive if the queen is not among them. But if the queen is with them it will settle during the night in its new hive. Should it be intended to form a second artificial swarm from the old hive, this should not be done sooner than four weeks, so as to give the young queen time enough to furnish the hive with an adequate supply of eggs. If the colony from which an artificial swarm has been produced is populous enough, it will send forth a natural swarm generally within fourteen days; sometimes on the twelfth, thirteenth, fifteenth, and even seventeenth day.

Bee-hives.—In bee-culture the most important thing is to adapt the hive properly. It must afford, on the one hand, protection against cold, which is the greatest evil, and, on the other, be convenient and of easy access for the bee-keeper, so that he may always supply whatever is needed and take away whatever is thought best, managing the whole in a practical and natural way. Besides, the hives must be cheap, easy of construction and for transportation, in case migratory bee-culture should seem desirable. No habitation of bees more completely answers these and other requisites pointed out in these pages than the Dzierzon hive, to which, at a meeting of the German bee-keepers, held in Dresden the 9th and 10th of September, 1857, the first premium was unanimously awarded. Its arrangement consists in the whole structure formed by the bees being movable—that is, the whole of the combs, or a portion of them, may be taken out and transferred either into the same or any other hive. This transfer is made from the side, every hive being therefore provided with at least one movable side door. This door is not like a common hinged door, as many bees might be crushed by it, but shoved square into the hive as far as the thickness of the door, perhaps an inch and a half. To prevent the door from falling in deeper, it rests against the ends of the cleats for the comb-holders or chimes of one-quarter of an inch thick.

The arrangement for taking out the combs is effected by fixing at the top little movable boards or sticks on which to attach them, they being fastened, as is well known, by the bees above, and built downwards in a perpendicular direction. For this purpose the side-walls are fitted, at equal heights, with grooves or cleats on both sides, to receive the little boards laid across for supporting the comb-holders. If the grooves are one-quarter of an inch deep, and the comb-holders at each end reach one-quarter of an inch into the side-wall, they must of course be one-half of an inch longer than the inside width of the hive, all of them, however, in the whole stand corresponding in length with each other, so as to fit into every groove. The most suitable length for the comb-holders is nine inches, some say nine and a half, some ten inches—one inch more or less making no great difference. As every comb, together with the necessary empty room on each side of it, occupies an inch and a half, every comb-holder must be one inch in width. It should be one-quarter of an inch thick, so as not to bend from the weight of a comb suspended from it. A hive measuring fifteen inches inside is therefore capable of containing ten comb-holders. Hence these form, below the upper exterior, solid or close cover, an inner and movable one resembling a grate. The distance between them, especially in low, recumbent hives, (*Lager-stock*,) should be at least great enough to admit the comb-holders to be conveniently taken out and transferred, say from three to four inches. In upright hives, (*Ständer-stock*,) from twenty-six to thirty-two inches in height, there may be several such movable grates, three perhaps being preferable, with the same number of grooves at the sides, the highest being put about two inches below the solid cover, the two others at equal distances, say from eight to ten inches apart from each other, else the combs would be too much prolonged and difficult to be taken out, on account of their weight and danger of breaking down. To afford the bees, however, an easy passage from one story or division into the other, and that everything unclean and the dead bees may fall to the floor, the comb-holders, originally one inch and a half wide, should be cut out upon their sides, either along the middle of both sides, leaving at each end one-quarter of an inch to project, so as to connect them with each other, as seen in fig. 4 *a;* or they are cut out towards both ends, leaving them to project in the middle as far as the original width, (fig. 4 *b;*) or they may project at both ends and in the middle, (fig. 4 *c.*) The comb-holders may also be made an inch thick throughout, and have wire pegs projecting half an inch towards each end to supply the space of that width, (fig. 4 *d;*) these pegs may afterwards be omitted, (fig. 4 *e*,) as by practice this distance can be ascertained by the eye and the fingers, and as the bees will so fasten the comb-holders with glue that they will not move even if they are transported. Of these different comb-holders, fig. 4 *c* seems to be the most practical, because a heavy comb may be easily taken hold of by the projection in the middle, even if but one hand can be used, while in the others the honey cells, sometimes extending a little too far out, may be partially squeezed and damaged. But fig. 4 *e* is the easiest to make, as a great number of these smooth comb-holders may be cut or split from a one-inch board. Instead of them, frames composed of little boards that are alike may be used, especially in those divisions exclusively destined for the collection of honey. In upright hives these frames are very convenient, especially in the upper division and near the doors.

Fig. 4.



As to the different materials for making hives, wood, straw, burnt or unburnt loam may be used. Wood, with straw forming an exterior cover, furnish bee-hives that are all which

could be desired whenever a warm wall is needed. The exterior of bee-hives may be of various shape and construction. They are sometimes in the form of small houses resembling pavilions, containing sixteen or twenty-four divisions for a like number of colonies; at others they are made in the form of closets or bureaus, with eight, six, four, or even no more than three divisions. Again, there are double and simple hives, the simple ones being undoubtedly the most useful; for, if made exactly corresponding, they may be placed upon and alongside of each other, forming, when thus joined, small houses, easily separated, should a change or removal of a hive, with its colony, be desired, while a compound habitation (a pavilion, for instance) cannot be so separated. We may, therefore, confine our description to the double hive and the simple one, the greater length of which extends along horizontally rather than upward.

Imagine such a hive, of four sides; let it be wider than its height, and divide it into two equal parts by inserting a vertical partition throughout its length. That such a double hive requires not as much work as two simple ones, since it is only half as wide, is self-evident. But as four such hives may be put crosswise upon each other, mutually covering and warming them, we may be saved the trouble of twisting or sewing additional protecting covers, a half-inch board wall above and below, fitting closely together, being all that is needed. The bottom of the lowest and the cover of the uppermost hive may be easily protected from cold by placing a layer of moss beneath the bottom and a straw mat on the cover of the top one. See fig. 5, representing one-half of a double hive only. Thus arranged, only the two side-walls remain exposed and require to be kept as warm as possible, which may be done by putting up planks parallel to the partition wall and at a proper distance, providing both with cover and bottom. It would be still better to use for these side-walls thin boards, letting the cover and bottom project from 1½ to 2 inches, inserting between such projections a corresponding layer of straw, to be fastened by laths. To make the fly-holes conveniently in the middle of both side-walls, at a distance perhaps of half an inch from the bottom, previously fasten the two laths (*a a*, fig. 6,) and let the fly-holes, about three inches wide or long and half an inch high, be made in the middle. Laths of the same width, though not quite so strong, may also be applied above, as shown in the figure, nailing to this and the lower lath the four cross laths for fastening the layer of straw. For the sake of economy these two laths may also serve to connect the side-wall with the bottom and cover by previously fastening the planks composing the side-wall to the laths, and then, too, the bottom and cover to the laths. Mortising and joining, as well as the instruments required for such work, may thus be dispensed with, a few long and short tacks being all that is necessary. The hive thus simply nailed together presents as beautiful an appearance as if made by the most skilful mechanic, especially if care is taken to give a nice finish to the straw trimming, which, with the two side-doors, are the only parts to be seen. This finish can be easily

Fig. 5.

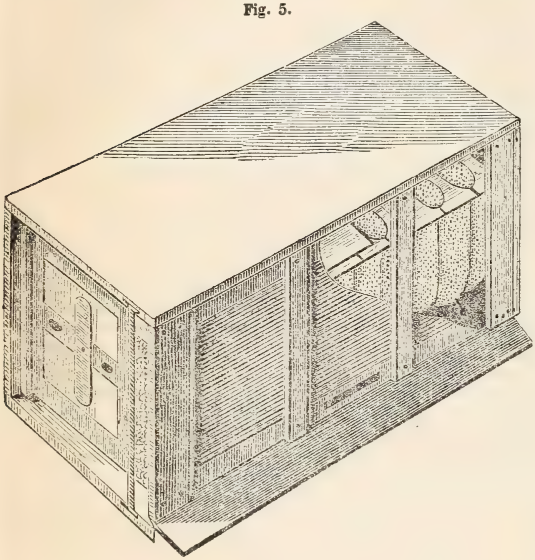
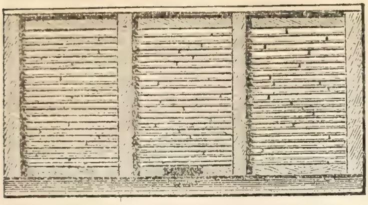


Fig. 6.

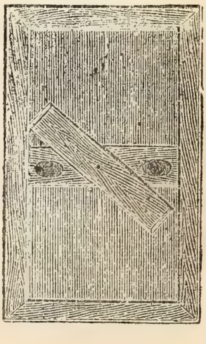
made by covering the layer of straw with one of reed nicely peeled, or with peeled and yellow colored willow-twigs, or with small boards overlapping each other like blinds. Reeds, such as grow on the banks of ponds, rivers, seas and marshes, make the cheapest and prettiest material, if, in cutting the pieces as long as the length of the hive, care is taken to insert them so as to bring the black colored joints under the laths, thus hiding them from view, (see fig. 7.) In preparing this protective straw or willow coat for the hive, put it on its side, lay the four cross laths on at equal distances, and bore holes both in these and the long ones for the tacks. Make the outer laths two, the inner one and a half inch wide, with the edges well trimmed, and they may also be painted. The laths meet above the cover, projecting a quarter of an inch, the projection and the laths being equal. If the upper lath is omitted, the cross laths must extend beyond the projection and be nailed to it. At their lower end they do not extend over the whole width of the lath that contains the fly-hole, but only to a supposed horizontal line below it, because at this line there is a board reaching through the length of the hive three to four inches wide. This fly-board, as it may be called, is put up in an oblique direction, to assist the bees as they fly in and to protect them from the rain and drain it off. This latter object will be attained by attaching this oblique fly-board to the lath and inserting one-quarter of its width into the lath, an oblique angle having been cut to receive it. Everything being ready, take off the laths and put in the straw first, the stubble ends alternately to the left and the right, so as to obtain uniform thickness; then put on the two side laths, keeping them somewhat down by tacks. Next spread a sheet of paper over the straw and put the reed over the paper, first thrusting one end of the reeds under one and then the other end under the other lath, pressing the reeds close together. After this, fix in the two middle laths, nailing them tightly to the long ones. Should the laths bend a little outward, nails may be driven in the middle, and, if their points should protrude, bent inside. To press the straw down very much is not only needless and adds to the labor, but it is also injurious, as the stalks thus become crushed and the air in them, which forms the best non-conductor of heat, is expelled. The points of the straw and reed which stick out at both ends should now be cut off with a sharp knife as smoothly as possible. If the reed, which, from its stiffness and the close-fitting of the laths, now forms a complete plane, be varnished, it will add considerably both to the handsome appearance and durability of the hive.

Fig. 7.



As to dimensions, a height of fifteen inches for the interior divisions seems to be best suited to the double hive. Twelve inches from the top, grooves are made on both sides of the middle partition which (the partition) must be at least an inch thick. The length and breadth should be so proportioned as to give the hive pretty nearly the form of a square, though the length may be three or four inches longer. If these hives are put crosswise upon each other there will be a little projection under each fly-hole. This is caused by the cover of the under hive, and serves as a support for the inclined fly-board of the one next above. Should the comb-holders measure nine inches in length, the width of each division in the inside will be eight and a half inches, and thus of both divisions seventeen inches; the external breadth, therefore, including the three walls, amounts to about twenty-three inches, and the length of the double hive may be reckoned at from twenty-six to twenty-seven inches. At both ends of each of the divisions fit in the doors, of boards fifteen inches long, nine inches wide, and about one and a half inch thick, using wood as soft as possible. If a passage three inches wide and one and a half above the bottom be made in the common partition opposite the fly-hole, and leading from one division into the other, and closed by a little plug easily taken out and inserted, it will be very useful for uniting colonies. To reduce the space occupied by a division at pleasure, a third movable door inside of each division is quite convenient. This little door may be a simple and thin board of the height and width of the hive, or two panes of glass set in light frames. For a more convenient hold for the hand, as well as a passage for the bees if desired, it has two openings which can be easily shut by a movable valve.—(See fig. 8.) This little inside door is shoved into the division about six inches on one side, and there fastened; the space thus cut off, and which reaches from the side door to this inside one, may be immediately filled with straw and the swarm let in through the opposite door, that it may make its brood-nest

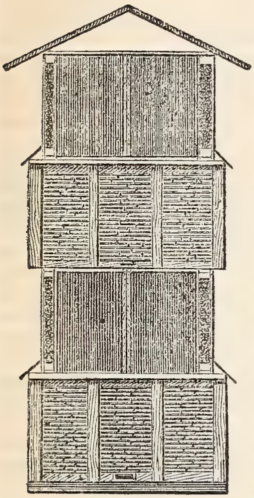
Fig. 8.



in the middle. Later, the same or the next year, let the bees be induced to carry pure honey into this space, which has been emptied and made accessible to them. This honey can be taken out of it in the most convenient manner. This space may likewise be used for the performance of various operations, as, for instance, in taking out the queen, and by pulling back the door the bees may be reached in their own nest without taking out the combs on the other side.

An objection has, however, been raised to the combined hives, including the double hive, on the ground that their simple manner of construction and management is destroyed; that a single colony cannot be sold separately, or removed in case of an attack by robbers, &c.; but it is very easy to construct simple hives without any sacrifice of the advantages of the double ones just described. Divide a double hive lengthwise into two equal parts by a vertical section, splitting the partition wall into two half-inch boards, and halving the cover and bottom, and we have two simple hives which, from their two back walls being always placed or leaned against each other, may be called neighboring, adjoining, or twin-hives. Dividing these double hives does not hinder placing them upon each other. Double or neighboring hives may be so placed at pleasure, covered with a little roof over the topmost double or neighboring hive.—(See fig. 9.) Simple hives have this advantage only, that each one can be separately shoved from its place, and an empty one of the same kind be substituted for it. The rear wall of a neighboring hive need not be very strong, the cover and bottom being joined to this wall by means of tacks. Near to the bottom, opposite the fly-hole, there is likewise in each neighboring hive an opening or passage, as in the double hive. It is closed by a plug, and opened only when a communication between the two neighboring or twin-hives is wanted.

Fig. 9.



This arrangement obviates also another objection raised to the Dzierzon method; that to carry out this method fully it is necessary to have another bee-stand about two miles off for setting up for a time the artificial swarms, and so preventing them from returning to their former stand. But since the construction of the Dzierzon hive the removal of artificial swarms is not required when the following course is pursued: In the spring before the bees make their first excursion, join an empty neighboring hive to every populous one, from which an artificial swarm is to be produced, and towards the time of swarming accustom the bees to fly in and out through both opposite fly-holes, and so through the empty division; or, for the same purpose, the hives may also be turned, thus changing the divisions and fly-holes. By closing the passage with the plug before mentioned, or with a shove door, and by furnishing the division not having the queen with a young brood, a full queen-cell or a young developed queen, a swarm is produced in the most simple manner. The reverse—*i. e.*, the union of two colonies—is effected with equal ease. This is often desirable, and even necessary in the fall after an unfavorable summer, or when a colony has lost its queen. For this purpose the communication or passage between the two divisions is restored by removing the plug, and the two colonies will unite peaceably, the more readily after one of the queens has been previously dispensed with.

These hives are likewise adapted to migratory bee-culture, as practiced in many parts of Europe, for instance, on the heathlands of Lüneburg, in Germany, Switzerland, France, Russia, Italy, &c. Whenever the vegetation of plants, to which the bees principally resort for their honey, ceases in one section of the country from climatical, geographical, or geological influences, or, generally speaking, from the peculiar distributions of plants, while it is luxuriant in another section, or on a higher range of mountains, bee-keepers remove their hives to the latter regions, keeping them there until the renewal of vegetation in their own. For this purpose the Dzierzon hives are well adapted on account of their lightness, and by taking out the full honey-combs they can be made still lighter. They are easy to separate and to reconstruct at any place upon two small sills or logs of wood, and in the same order which they before occupied; so that the bees, recognizing again the same building, can readily find their own hives without going astray in a mass, as they do when there is a great number of equal or similar hives put up in one long row which may cause the death not only of many workers, but also of the queen. It may be observed, in general, that a hive which is too small will never produce a surplus of honey, and sometimes not even the amount necessary for the consumption of the bees. They, indeed, show a greater disposition to swarm in small hives than in large ones, but these swarms are poor, as they result mainly from want of room rather than from a populous colony. If, on the other

hand, the hive is too large, a colony newly hived feels almost discouraged for work, especially in the case of a small swarm and in a poor locality. Hives not quite filled up with combs, and as yet unfinished, are always colder than those completely built up. If made of boards which are too thin they neither sufficiently resist the effect of the cold nor of the heat, but thick walls serve against the extreme heat of the summer as well as the great cold of the winter. Thin boards besides are more liable to burst and warp than thick ones. Boards made of soft wood, as the cypress, linden, poplar, &c., are generally better than those of oak and similar kinds of hard woods. Stone or burnt bricks are too hard and cold; they are liable to sweat in the winter, thus producing injurious moisture. Bricks dried by the sun are a suitable material, and loam would be well adapted to the purpose, if it combined greater durability.

A suitable hive must be so constructed as to afford a convenient examination of its interior, which ought to be so far open to the eye of the bee-keeper as to enable him to take at once a comprehensive view of the inside arrangement, the combs, and the condition and works of the bees. Those hives, therefore, which have an opening from below only, cannot be ranked among practical ones; for even placed on their side, or on their top, (often a rather hard job,) it is only with the greatest difficulty that a few bees may be discovered, while the eggs and worms can hardly be seen in the points of the combs, so that a view of the whole is altogether out of the question.

If the colony has lost its queen, suffers from dysentery, rotten-brood, or any other accident that requires something to be done, it is as difficult to do it in such a hive as if within the body of an animal. Many combs, and good ones, too, must often be cut off in order to ascertain the condition of a colony of doubtful health. Though the experienced bee-keeper will, from the excrements below, form his conclusion that the bee-worm has already invaded the combs, threatening the very existence of the colony, he can with only doubtful success use the knife in the dark—the portion cut off, if still sound, being inserted again with difficulty; while in the better constructed hives, like the Dzierzon, the sound portions of the combs and the life of the colony, too, can be easily saved.

As these and similar inconvenience and disadvantages are common to all other kinds of hives, the Dzierzon hive has been pointed out for obviating these difficulties and meeting the requirements of a practical and scientific bee-culture of the present day. By this hive we cannot only look, if necessary, at its contents—combs, honey, brood, eggs, and the bees at work—but also, without being obliged to cut or injure the cells, perform in it every necessary operation, as, for instance, take out the surplus honey, or single combs, either empty or filled with honey, eggs, or brood. A hive not yet of sufficient strength, by placing within it the needed quantity of full and covered honeycombs, may within half an hour be put into the proper condition for winter. This hive gives the bee-keeper full power in rearing bees, enabling him to divide and unite again the colonies in the easiest and surest way, to find out defects and diseases, and adopt remedies in the shortest possible time, thus providing against losses. The Dzierzon hive is truly a triumph in bee-culture, as it forms the basis of successful enterprise. It is well adapted, not only to poor seasons, but it is eminently suited to remunerate the bee-keeper in abundant ones for the cost and labor he has had to expend in other years without realizing any adequate profit.

As has been stated above, the comb-holders should be furnished with small pieces of comb of at least two fingers in width to induce the bees to continue them. In countries with long winters there are plenty of empty wax-combs in the spring, which, when properly set up and stored away in airy places or bags, so as to be protected from the wax-moth, can easily be preserved for future use. The advantage is thus gained of furnishing natural and artificial swarms with empty wax-combs enough for half their hives. In the South there are no empty wax-combs, as it is not necessary for the bee to provide for a winter season destitute of food, nor can she foresee periods of great drought. Here it is where the bee may be said to live altogether from *hand to mouth*, that is, from the supply which it daily gathers out of the abundant richness of Nature, without feeling the necessity of providing for a rainy day. While not so much dependent here on its supplies deposited in the hive as in other countries, it is also capable of enduring hunger for an almost incredibly long period. Instead of supplying swarms with whole wax-combs, bee-keepers of the South must, therefore, be satisfied to furnish them with the narrow pieces of comb above mentioned to start with. These pieces must be made to adhere to the lower side of the comb-holders. If there are not wax-combs enough to affix to all the comb-holders, then every second or third comb-holder should receive one of them, beginning with the second holder and leaving the first empty. Such comb-holders as receive no pieces of wax-comb should be freely and smoothly rubbed on their lower side with wax to lead the bees to attach their combs to them, thus diverting them from attempting to build their cells across the comb-holders, which would prevent the combs from being taken out. In order the better to attach these pieces, they may first be dipped in wax heated on a plate, after which they should be quickly transferred to the holders and pressed upon them. Combs of pure wax may be bent round

and gently pressed on the holders that are heated. They may also be fastened upon them by means of putty.

In poor localities the capacity of a hive should not exceed 2,000 or 2,500; while in richer ones it may reach to from 3,000 to 4,000 cubic feet. The number is ascertained by multiplying together the height, length, and breadth inside. Thus, the capacity of a hive 24 inches high, 14 long, and 10 wide, would be 3,360 cubic feet.

All hives of one and the same stand should be of a uniform width in the inside, say from 9–9½ or 10 inches, for even a difference of ⅛ of an inch prevents the exchange, transposition, or transfer of the combs, which constitutes one of the main points of the Dzierzon method. If the comb-holders be longer than 10 inches, being but ¼ of an inch thick in the middle, they will bend from the weight of the honeycombs, and thus become liable to slide at both ends from their supports, causing much damage by their fall.

To prevent the bees from at once entering the upper room and commencing their work; to force them, for instance, first to fill up the middle and lower rooms of the upright hive, and to place their brood-nest there, the comb-holders should have a cover. For this purpose select thin boards which can be easily split into about the thickness of the lower part of a shingle. Their width may vary from 3–9 inches, and their length the width of the hive, so that they can be put on lengthwise or crosswise, as the room to be covered may require. It is not necessary to join them accurately to each other; when of sufficient width they may be laid one over the other, leaving in part a hollow space between them and the comb-holders, which may thus make it more convenient for the bees to pass from one space to another. All hives, modern or old-fashioned, should be provided with a special honey-room, filled out with tow, rags, hay, straw, or similar material. This is to be removed when the lower brood-room has been nearly filled up. The honey-room itself should be one-quarter or one-third of the total room of the hive, and always placed in the upper part of the hive, as the bees will begin too late to carry in honey at the sides or below. The queen will not go up through the small opening—which is about one inch wide and extends the whole length of the hive, sometimes on both sides, through the upper layer of honey—to form her brood-nest. On this account both the honey and wax there deposited always remain clear and pure, much better in appearance for the table than that which is deposited in former brood-cells.

No bee-hive, of whatever construction, should have its fly-hole quite at the bottom, as wax-combs will occasionally break down, obstructing the opening and thus preventing the bees from flying in and out, so greatly increasing their anxiety and heat when thus imprisoned that the colony will often perish. Hives of a considerable height must be provided with two fly-holes, the one at the bottom, and the other above the centre. When most honey is collected both holes should be kept open, but at other times the one around which the bees are most busy will be sufficient.

Hives of glass are also used. Though they offer no greater utility than wooden ones, and though the thorough bee-master prefers an immediate intercourse with his bees to the protection by glass, yet these hives are very pleasant to the wealthy and timid, and more so to the majority of the ladies. When President of the Bee-keepers' Association of Silesia, in Germany, the writer, besides other hives, had always glass hives in store, in order to satisfy the frequent applications for them. One kind was cylinder-shaped, and made altogether of glass, while another was quadrangular, the four sides having glass panes, with their edges set in a wooden frame like a lantern. They had to be protected, however, both from the rays of the sun and the cold by being surrounded with wooden cases, and even then they proved to be too cold and too wet for that country, while in this country there is no fear of their being so, the case itself being rather a protection against the rays of the sun. By stuffing tow, cotton, or rags between the glass hive and its casing the influence of extreme heat and cold may be modified, thus preventing the sweating of the inner side of the panes in winter. Glass panes between the door and the bees, each pane as high as the door, are beautiful in appearance, and quite harmless to the bees in wooden hives. This arrangement also affords the timid a good opportunity of carefully watching and observing the bees at work. As to what is said of bees pasting over the glass with glue, this can only be done where there is but a small window of the size of a hand.

The advantages which the Dzierzon hive and a practical knowledge of his method affords have seemed to justify dwelling at length and particularly upon this part of the subject. This is due to the man with whom the writer co-operated for years in this branch of industry, and whose researches and discoveries have been verified by the light of science, confirmed by the results of experience, and acknowledged by all who first assailed his theory with unbounded violence. It came out of the conflict triumphantly, and is now recognized over all Europe as the standard of practical and scientific bee-culture.

In advocating the Dzierzon hive, it has been felt to be a duty to make this standard of a rational bee-raising known as widely as possible.

The omission to mention in the course of this article the good points of other hives was

not from a want of attention to them, but because the Dzierzon hive combines all the good points of a useful hive, and from a conviction it will contribute largely to the general promotion of bee-culture to urge a uniform adoption of his method and hive.

For this purpose, and as fully believing in the ultimate success of this system, the writer mentions with gratification the fact that he has already received a great number of applications from all parts of the country for printed instructions and models of the Dzierzon hive. And as still further evincing the interest among the bee-keepers in the adoption of this hive, it may also be stated that frequent requests have been made to send these hives to different sections of the country, a request the more readily complied with on account of a knowledge, by experience, of the difficulty of constructing a hive, even though the most detailed description is furnished. Especially is this the case with beginners. Either models or specimens of the following hives have therefore been sent to applicants:

1. The simple hive. 2. The double hive, lying or standing. 3. A painted window hive, with two side doors and glass panes behind them. 4. The same, unpainted and without glass. 5. A four-sided glass hive. 6. A hive of one thousand cubic feet, for keeping queens on hand. All these hives are of course provided with comb-holders, and a specimen of the queen cage (fig. 3) is likewise added.

Position or aspect of the hives.—The question in which direction the bees should be made to fly out, or the fly-holes be turned, is of no great importance. The bee-keeper may be wholly guided by the convenience of the situation of his garden. A southern slope, with the refreshing breezes affording coolness to the hives, and hill-sides or mountain ranges in the North giving shelter from the north winds, is a very proper location. So, too, a close board wall on the north side will prove very efficient in keeping off such winds. A warm sunshine, after a fresh fall of snow, will often induce the bees to leave their hive. As their eyes become dazzled thousands fall to the snow and perish. To prevent this, a thick layer of ashes or straw should be strewn in front of the hives. To close the fly-hole would but make the evil greater, as the bees, from heat and anxiety, will be likely to kill each other.

Taking out honey.—The time of taking out honey, or if it should be wanted in unfavorable years, of cutting off the empty wax, is different in different countries. In those which have a climate like that of Germany, about fifty degrees of northern latitude, it is best to wait until spring, to see whether any and how much honey has been left from winter. In this section of country, (Texas,) however, no store of honey is required for any season of the year. It would even be risking it, on account of thieves and other accidents, to leave much honey in the hives, as our periods of want (so great that no European hive could endure it) cannot be anticipated. In this case it is hardly advisable to feed them, even though there may be a supply of honey, for should the drought continue, the bees, if not roused from this state of want and a life of lethargy, may thus drag their lives on for months; but if stirred up by being fed they awake to a greater activity, consume a great deal, and become expensive; or, if fed only occasionally or not enough, they become still more depressed and perish. The supply of honey which remains from the fall, no matter whether 15, 20, or 50 pounds, is always used by the bees for raising their young. If a great drought occurs, honey and labor will have been expended in vain, as all hives will appear equally weak in the fall, but in case of a rain they rapidly recover. In the South, therefore, the honey is taken out as soon as the hives have been filled, a little only being left. Taking the honey before hives are filled is not relished by the bees. Many years honey is taken out two or three times, for the meagre seasons are often followed by those of abundance. In Northern localities it is only in the most favorable summers that honey is gathered in the little boxes attached to the outside of the hive, for it is not advisable to cut the honey at the top of the hives a second time, because the bees might neglect to fill up the space, and the hive thus become too cold in winter, especially if it is not of the Dzierzon construction.

Feeding of bees.—This is an important and diversified subject. Bees, if it can be avoided, should not be fed at all. This rule may be carried out in the South, there being a short time only when the nourishment ceases to feed during the drought—the commencement and duration of which is altogether uncertain—is, as already mentioned, of doubtful success, and it is even done at a risk. Should a hive here, in an ordinary season, become so weak that it is doubtful whether it will sustain itself until the appearance of future food, it should be furnished with a few combs of brood, eggs or honey, as needed. A very weak colony, of the size of the head of a child, will stand the want a much longer time here (Texas) than in the cold winter of the North, where every colony, even with plentiful food, must perish, unless it can generate its own warmth by its numbers, especially if, as a swarm, it has young, fresh, and therefore colder wax-combs. In the North, therefore, populous hives should principally be raised, which by little attention is not very difficult in that section of country, usually having more uniformity of climate, and consequently more certainty in the production of food. Weak hives are always troublesome, often perishing even in the spring from cold, hunger or from attacks by robbers. Weak swarms should always be united with others into one colony; and if such a colony still remains in a weak condi-

tion, or if the summer proves unfavorable, so that some of the hives cannot collect sufficient food, two or three such colonies should be united in the fall, about the close of September—a period at which most of the honey is gathered with us. The whole number of bees in those two or three united colonies will consume little more than each would have required when separate, and the remainder of honey taken from the two broken-up hives furnishes sufficient supply for the union of three. The elder queens should be driven out, in order to save the young queen and to keep her from any injury in the struggle that would otherwise ensue. To prevent the bees from attacking each other too violently when the union takes place, it is advisable to spatter both colonies with a little rarefied honey mixed with a few drops of spirits. If the colonies that are to be united are housed in straw hives, they may be placed during the night one above the other, after first removing the cover from the lower one. The odor will thus ascend from the lower hive into the upper one, imbuing both colonies with one and the same smell, by which they recognize each other and associate together.

But when a bee-keeper, instead of diminishing the number of his hives by a union, desires to carry them as they are through the winter, and has not a sufficient supply of honey to hang in the hive, covered without adding water, or to place it above the setting place of the bees, (to put it on the bottom is not advisable,) he should never use honey with the purity of which he is not fully acquainted, otherwise he will most likely create rotten-brood among his bees. This disease originates from the use of honey unfit for raising young bees. It is true, some colonies might be saved by transferring them into new hives and feeding them with pure honey, in case there is a supply abroad in the fields; besides, the new hive should at once be put aside and the pure honey taken out; but as the cure is difficult, especially if the case frequently occurs, it is best not to attempt any further remedy than to break up the infected hive and destroy the bees by sulphur.

Feeding bees with a decoction of pears or molasses, though it has not always proved injurious, is not to be recommended, nor has it proved satisfactory to place undissolved sugar-candy for this purpose above the brood-nest. In years of distress good honey is too expensive to be used as food for bees. But if so used, when clarified and separated from the wax, it must be mixed with water—two-thirds of honey to one-third of water, mixed by boiling, and given lukewarm to the bees. Next to honey, the best healthy and cheap food is sugar; one part dissolved in one part of water, and boiled together until the solution becomes thick and ropy. It is given to the bees before it is cooled off. In all hives with a cover and bung-hole, the earthy feeding plate should be placed on the cover after removing the bung. The bees are attracted by the smell, and may at first be stimulated by a few drops of food poured in; they thus ascend through the bung in the feeding plate, the middle of which has an opening in the shape of a cylindric chimney. This chimney, however, does not extend as high as the edge of the plate, so that the bees may pass in and out under the shelter of the plate-cover without being troubled by other bees in the feeding plate, measuring from two to three quarts. The liquid food contained in this or any other feeding vessel should be covered with stalks of straw, thin shavings, or very thin pieces of board, having little holes or crevices in the middle, to prevent the bees from drowning. The other feeding vessels, besides this plate, which is of the best earthenware, may be of wood, as they keep the food warm for a longer time. They usually consist of troughs five inches long and three wide. There is, however, some trouble and loss of time in repeatedly bringing and arranging the feeding troughs in the hive, and it is more convenient to fasten two nails below the fly-hole and place the trough on them, with its upper edge reaching the fly-hole; the bees should then be induced to approach the fly-hole, by inserting a little warm food, breathing into the hive, or knocking against it, or any other suitable means. Afterwards they will come to the fly-hole of their own accord. Let every bee-keeper, however, earnestly bear in mind never to feed his bees during daytime, otherwise robbers may be attracted, and his own bees may become so. He should not even do it in the feeding plate above mentioned. Though the other bees cannot reach the food in this plate except through the hive itself, yet, by the loud humming of the feeding bees, they will be too much incited to robbery. Even if a bee-keeper has but a single hive, with no other bees near him, he should never feed his bees during daylight, because some other bees might still be attracted to his hive. The feeding should commence shortly before the dark sets in, the empty vessels being taken away early in the morning. Some feed their bees early in the spring, not from necessity, but as a matter of speculation, in order to raise many early swarms. This is alogether impracticable in countries where the weather is uncertain, and, even if it is quite reliable, it may still become enough at the time of swarming, when the queen-cells will be destroyed, and the swarming deferred for some months to a period when the larvæ will have reached again a certain stage of growth. During all this time the bee-keeper is obliged to feed a number of bees without profit, so that this forced method, uncertain as it is in its result, evidently deserves no recommendation. On the contrary, one hive or several hives, in consequence of favorable weather, may become populous and apt to swarm; but now unfavora-

ble weather sets in. If such hives are not assisted, they will swarm about four weeks later, because the bees, on the weather becoming bad, will destroy the cells of the young queens. In this case it is best to feed a colony every day with rarefied honey, either to compel it to swarm or to induce it to spare the queen-cells. The best way, however, is to make an artificial swarm and to feed it in bad weather, while young.

Transfer or removal of bees.—It is rather difficult to transfer or remove entire colonies with all their combs from hives that are damaged or otherwise unsuitable. All honey and brood-combs must be cut out of such hives and introduced into the new one, and, in doing this, not only much honey is lost by dropping, but also more than half of the brood. In Texas a colony was once transferred which, within three days, altogether flew off, taking the queen with it and deserting its young brood, though there was at the time such an abundance of food in the fields that the colony might, within eight days, have comfortably settled in its new hive. In general the colonies transferred, both natural and artificial swarms, sooner remain in their new hives in bad than in good weather, if it suits them in other respects. It is best to drive the queen with as many bees as possible from the hive, and, after about twenty days, to cut out all the combs of the old hive. The new hive should occupy the place of the old, which may be put up at some distance from it. After the twenty days the young bees will all have emerged from their cells, forming a new colony, which, if populous enough and it has a young queen, should be put in a new hive, or it may be united with some other colony, in the evening, by fumigation and a sprinkling of honey, or the bees may be left to themselves to join some other hive after their old habitation has been altogether removed. In this union, as in any other, it should, as far as possible, be the rule to unite only bees of the same kind or condition—that is, those of a productive queen should be united with bees only that also have such a queen, while those of an unproductive queen should be united with bees that come from a similar queen, for bees from hives of similar condition are best adapted to each other.

In countries where bees are prevented by the cold of winter from flying out at least for two months, it is best to transfer them to a particular standing place. In making this change the fly-holes must be stopped, but they must be opened again after the bees are put up in their winter quarters. This removal not only saves food and affords protection from the cold, but the risk of the bees being ruined and the hives stolen is thus also avoided; as in winter they are prevented by torpidity from defending themselves, entire bee-stands might in this season be destroyed. It is hardly possible to provide bee-houses sufficiently with locks; at all events, it is expensive. In transferring the bees to their winter quarters, the following rules should be observed.

1. The transfer should not take place before the frost has set in—never before 3° R. = 38°.7 Fahrenheit.

2. The winter quarters should be absolutely dark, else the bees will fly from their hive without being able to find their way back.

3. A dry cellar should be chosen, or rooms with covered windows, which allow neither the warmth of a stove, nor evaporation from a stable or from cattle.

The hives may also be placed in barns among hay or straw. If warm weather sets in after their transfer, the holes of the cellar, &c., may be opened during the following night for the purpose of cooling the stand; for it is always better to keep their standing place a few degrees below than above the freezing point; but no particular ventilation is required. There are many villages in Germany having a common subterranean place into which hives are transferred, watching them and looking after them from time to time. In such cases the fly-holes must be made more narrow, so as to protect the bees from mice. To bury them in the earth, as above described, without admitting air, forms likewise good winter quarters, as the bees require still less food.

Purifying honey and separating it from wax.—Put all that has been cut out in a pot, or, if much, into a kettle. Heat it gradually over a gentle fire nearly to the boiling point, (if the mass actually boils, there will be impurities in the honey, giving a bitter taste,) and set the vessel afterwards in a cool place until the whole is completely cooled off. In the South twenty-four hours should be allowed for cooling—at any rate, the whole night—else the bitter bee-bread (the pollen) will not adhere to the under side of the wax, but will sink into the honey, imparting to it a bitter taste. After it is cooled down, cautiously take off the layer of wax at the top, (if wooden vessels are used, it cannot be easily removed unless they have been previously wet,) and the remainder is pure honey, obtained without the use of a sieve or filtering cloth, and which always keeps well in any vessel. As much honey still adheres to this layer of wax, it is therefore boiled once or twice with water, and the sweet water thus obtained used for metheglin, soups, hot beer, or vinegar. Finally, the wax is again mixed with water and once more boiled; the mass is then poured into a bag and strongly pressed. Both the water and wax run through the bag, and what remains in it is burnt or thrown away. The wax cools upon the water, and is then ready for sale or home consumption. If there be a large quantity of honey, it may also be filtered through fine

baskets or wicker-work, or through a filtering cloth. This method takes longer than boiling, and though some fine particles of wax will pass through, yet the honey retains more of its aroma and natural flavor than when it is boiled; many persons prefer this method, and call the honey so obtained virgin honey. It should be recollected, however, that no force or pressure must be used in this way of securing the honey. All that passes not through unforced should be treated according to the method first described.

Preparation of metheglin.—The sweet or honey water obtained from the operation of purifying or clarifying the honey above mentioned is boiled in a kettle and repeatedly skimmed off. The boiling continues until the mass has attained such a consistency as to bear a hen's egg, with its point reaching out of the liquid. If there is not honey water enough, or if none at all, the difficulty may be remedied by mixing honey and water, the honey being one-fourth to one-third of the weight of the water. After it is sufficiently boiled, cool it off, put it into a cask so as to fill it nearly full; then bring the cask into a place of from 10–12° Reaumur, = 54–59° Fahrenheit, covered with a cloth, and allow it to ferment. After six weeks, and in warm countries much sooner, filter it through blotting paper and put it into small casks. What remains may be filled into bottles, which are closed, but not tight, with a rag, and put away in a cool place. The fermentation also continues in this second cask, which is but lightly closed with a bung covered with a cloth. The mass in the cask is gradually reduced by fermentation, so that what remained in the bottles can now be added. After nine or ten months the metheglin is again put into another cask, with the bung driven in tightly and the cask set in some cool place. When completely fermented a healthy beverage is obtained, that well bottled air-tight will keep for a long time and continually improves.

Honey wine.—Boil slightly thirty pounds of honey and sixty quarts or fifteen gallons of water for two hours, skim and cool it off and treat it like metheglin, except that a nutmeg and one ounce of coarsely-ground cinnamon are put into a linen or cotton bag, and inserted in the bung hole, and thus kept suspended in order to impart an aromatic flavor to the wine. This beverage, similar to the Spanish grape wine, but excelling it in quality, invigorates the stomach, promotes digestion, purifies the blood, and is very beneficial to the chest.

There is another kind of honey wine, which, by being kept bottled a few years, will equal the best Madeira, and form a most delicious beverage, though it is somewhat troublesome to prepare it:

Mix forty pounds of honey with eighty quarts or twenty gallons of running water, put it into a clean kettle, gently boil it and skim it. After thirty minutes gradually add five pounds of finely-ground chalk, continually stirring the mass. Skim off the tough substance which gathers at the top of the kettle until no more of it appears on the surface, then pour the mass into a vessel, allowing it to subside and cool, so that the chalk may settle. Let the kettle in the meanwhile be thoroughly cleansed of the chalk remaining in it, and the mass carefully poured back again into the kettle, with an addition of nine pounds of finely pulverized charcoal, and then gently boil the whole for two hours. Put the liquid again in a clean vessel to cool off a second time, after which filter it through a pointed bag of felt or flannel. After this pour the liquid once more into a kettle and heat it up to the boiling point. Then take the whites of thirty-five eggs, mix them with water, stirring the whole until a foam appears, and add it gradually to the other mixture. The liquid is perfectly clarified by the addition of this foam, which takes off the particles of charcoal that may have remained, together with other impurities.

The chalk removes the acid taste, and the charcoal that of wax. The liquid, after the whites of eggs has been added, is gently boiled another hour, allowed to cool down, and then filled into a cask having a small space empty about the bung hole, which is lightly covered with a piece of linen so as to permit the mass to ferment. The additional treatment is the same as before given. Clarified in the cask and bottled, this wine will keep for an age. Cool cellars of from 3–4° Reaumur, = 38–41° Fahrenheit, are, of course, a main requisite. The bottles are to be laid in wet sand, on which salt water is occasionally poured. Metheglin honey, even when young and not yet possessing much vigor or spirit, will make a pleasant beverage mixed with tart, especially red wines. All tart wines, in general, can thus be made agreeable and thoroughly improved.

The question whether the inhabitants of a city can also enjoy the pleasure of keeping bees must be answered in the affirmative, and all who doubt it may be convinced by trying the experiment. Put the hives, if possible, in the windows of side rooms, attics, or of rooms the windows of which look into a garden. The bees will do no injury, and the family or neighborhood need not be afraid of the children being stung, for bees in search of their food do not care for the thousands of men wandering below. Should some of them be blown down by the wind, they are fearful; and the harmless swarms do not settle below, but on the gable ends of the house. Besides, there will be no natural swarms, if artificial ones are made. The food, it is true, is not so easily accessible for them, if they have to fly

off a mile or so, but still it is not beyond their reach. Besides, the flower gardens of a city and the trees lining the streets or ornamenting the public places will afford them a good deal of nourishment. In confirmation of the above assertion, it may be stated that the bees in the hives shown at the Industrial Exhibitions at London, 1851, and at Breslau, 1852, were lively, flying in and out, busily engaged in their work among the throngs of men. That they felt quite comfortable is seen in the fact that, by hatching a queen, they made preparations for swarming in the latter place. The naturalist especially would be benefitted in his observations by keeping bees around his place of residence in the city, since it would afford him ample occasion of raising the wonderful veil hanging around the secrets of Nature; be a delight to him to watch the industry of these insects; to hear their pleasing hum, and to smell the scent of the fresh honey filling his room with aroma. To keep bees around the house would likewise benefit persons suffering from diseases of the lungs by giving them a chance frequently to inhale the delicious scent emanating in spring through the fly-holes from the honey imbued with the sweet odor of flowers. The inhalation of this aroma is certainly more agreeable and effectual in such diseases than the promenade in cow-stables recommended by physicians.

In presenting his views to the public, the writer has not so much desired to offer striking novelties, often without foundation, as to point out the peculiar features adapted to this country not generally known, though simple in their character. And on the principle that food is not for those whose hunger has been stilled, it has been the aim to present information to bee-keepers generally, and especially to beginners, being ready to answer all objections and inquiries that may be made. Hoping that this most productive branch of agriculture will receive the general attention of the country, the immediate formation of a United States Bee-Keepers' Society is also earnestly recommended.

A FEW NOTES UPON THE MORE RECENT DISCOVERIES AND IMPROVEMENTS IN PISCICULTURE.

TRANSLATED AND CONDENSED FROM THE ORIGINAL GERMAN OF DR. FRAAS.

We select the word pisciculture in preference to either Fish-Propagation or Fish-Breeding, because the one means too little, the other too much. Artificial propagation *per se* may be practiced in any fish-pond or stream, the rest being left to Nature. Fish-breeding would imply artificial propagation of merely the more valuable descriptions of fish, with a view to improve or develop certain qualities, as effected in various domestic animals—the horse, the ox, and the sheep. Pisciculture takes a middle course, being the science, firstly, of artificial fructification or impregnation of the ova of fishes, and, secondly, their care during, as also for some time after, their development, until they can take care of themselves, its object being to raise an important article of food for the use of man from sources otherwise worthless.

Although all that has hitherto been effected in this branch of industry has proved useful, practical, and deserving of attention, yet we are far from the realization of the boasts of enthusiasts who aim at nothing less than the replenishing of all our lakes and rivers with fish, so as to supply our poorer classes with an article of food at once nutritious, plentiful, and cheap.

It is a well-known fact that the various species of salmon can be easily propagated, not only economically, but also in the greatest abundance. The following are some of the most esteemed of this class: The trout, Salmo Fario; the bull trout, S. Salar; the huck, S. Hucho; the sea-trout, S. Lacustris; the grelse, (query?) S. Umbla; the grayling, Thymullis. The pike may also be included. They may be preserved in boxes, wires, or nets in running streams during the spring, summer, and autumn months, according to the method described in my treatise on the subject,* nothing more being needed than a temperature of 4° to 7° Reaumur, = 41° to 48° Fahrenheit.

Carp, tench, barbel, perch, &c., which are propagated during summer, cannot be bred in

* Fraas künstliche Fischerzeugung, 2 Auflage, Müchen. Liter. artist. Anstalt.

such streams, as their ova are too small and numerous to be able to be looked after or cleansed separately, besides which they require a higher degree of temperature, say from 10° to 20° Reaumur, = 45° to 65° Fahrenheit, which is only to be found in the standing waters of fish-ponds and of a few rivers, where they multiply in extraordinary numbers, without any artificial aid.

It has, however, been sufficiently proved by embryologists, as well as pisciculturists, that these kinds of fish can be propagated easily if the impregnated ova be placed in water of the required temperature where they can attach themselves to the different aquatic plants or stones. At the expiration of eight days the ova are hatched, and the young fry are not injured by the fungous growth of the decaying ova, being separated from each other at great distances, and the process of hatching occupying so short a time.

Suffice it to say that the salmon species can be propagated with great certainty in vast numbers, at least two-thirds of the ova arriving at maturity; and when it is considered that these are esteemed among the most highly prized of fresh-water fish, we can readily conceive the great importance of the art of pisciculture.

As fish can be retained in proper receptacles until they are enabled to seek food for themselves—a period of from six to eight weeks—one would suppose that they might be propagated in unlimited numbers; and such, indeed, would be the case were it not for the vicissitudes to which the young fry are exposed. It has been the chief aim of the art, of late, to remove these. We will suppose a fish-breeder to possess some 6,000 of the salmon species, say six weeks old, in a box. They float already in the water; the yolk membrane, or umbilical chord, has entirely disappeared, and they dart after filaments of pounded meat or fish.

A whitish stripe on a black back marks the trout; a reddish hue the Rhine salmon; light blue, with dark spots on the sides, the red charr; if still lighter blue appear, pike; and yellowish, grayling. He now transfers them to a larger piece of water; to a cool trout stream, or a small lake through which such a stream flows. The stream overflows the upper edge of the box, most of the young fry cower frightened to the bottom; one by one they effect their escape; they are carried away by the current, but, always turning towards the shore, they at last succeed in reaching it, if they have not already found shelter under a stone, a leaf, or some aquatic plant. Under this shelter all remain quiet. They continue to hide themselves more and more, till, at the expiration of a few days, out of the many thousands, only here and there a trace is to be found. Now come the trials of the young brood, and now the most difficult part for the breeder. All descend the stream more or less, according to the species. The trout is seen two or three weeks after the transfer basking in the shallowest parts of the rivulet, protected against the rapacity of larger fish by the shallowness of its resort. Now and then they will swim about; but they are chiefly found lying quietly close to the bottom, where they can be caught by the hand. In this state they fall an easy prey to the larvæ of the great ephemeris. Every small fish of the herbivorous class, particularly the Phoxynus lævis and the Golio saxabilis, prove at this time destructive to the fry of the salmon and trout, feeding upon them as upon worms. Fish of prey, as the pike and perch, prove still more destructive; even a single grown trout is capable of destroying in one day 10,000 of its own species, if it can only catch them, which it certainly will do if the young fry are carelessly placed in the water without observing certain rules. The only protection, as incidentally said, is shallow water; therefore trout only frequent deep water when they are strong enough to dart suddenly from it to their places of refuge when pursued. Trout seldom leave their breeding places; they have their favorite haunts, to which, if driven away, they will always return.

This, however, is not the case with the salmon. They descend the rivulets and larger streams to the lakes. If obstructed, for instance, by wire snares, they congregate together, seek to escape, but not succeeding, emaciate, pine away, and many die, spite of every care.

The French pisciculturists committed a grave error in mixing, indiscriminately, the fry of the herbivorous with those of the carnivorous species, intending the former to serve as food for the latter, for the temperature at which the latter were hatched would not mature the ova of the former; consequently grown specimens of the herbivorous were placed among them to serve as food, but being large in size they devoured the fry they were intended to feed. If pisciculture do not also include protection against the wholesale destruction of the fry, the result will not compensate the labor bestowed upon it. Careful protection of the breeding waters alone would lead to the same results as artificial breeding, excepting in the transplanting of new species. There are methods of obviating these adverse circumstances. Even a description of stable feeding, if I may be allowed the expression, may be practiced with advantage. Even the immediate transplanting of small fry into waters swarming with their enemies may be effected without loss, if only needful precautions be taken. As little as it would occur to a cattle breeder to drive a foal or a calf into the open prairie, immediately after weaning, to seek its own food unprotected, so little should the pisciculturist leave the young fry to shift for itself after artificial impregnation and hatching.

We will now proceed to illustrate two methods of raising fish artificially:

1st. We raised trout in a channel that had been dry. It was about three feet wide, the water about one foot deep. The current had a velocity of about six feet per second in the middle; at the sides much less, as these were coated with cresses and other water plants. Here and there were holes of from two to two and a half feet deep in the pebbly bottom. After placing the breeding box in the stream, with fry of about six weeks old, they disappeared among the plants within forty-eight hours. In order to distribute 2,000 fish according to their habits, it requires a canal of at least a mile and a half (English) in length. Each one will take up its own haunt to which it will always return.

2d. Some trout were kept in separate stone receptacles, through which a stream of spring water flowed continually. At the expiration of a year I found them two inches and a half long, although they had never been fed, nor could I discover by what means they existed even in the spring itself. But as it is a well ascertained fact they do not *feed* on water, but live upon other fish, either living or dead, larvæ, insects, worms, bacillaria and diatomea of the mud, infusoria and molluscs, and but rarely on the decomposing parts of plants, it is evident that a very large number of fish in a given space can only be kept alive by artificial food; and here we will remark that all our waters contain more food in proportion to the fish that are in them, which can be proved from the well authenticated fact that in times past they contained larger quantities than now.

The larger species of salmon are easier to rear, even in a smaller space, than trout. The Salmo umbla, the most esteemed fresh water fish of Europe, is found only in the lakes of the Alps, and then only seldom, excepting a few localities. It spawns during the months of December and January, (and is to be caught easily at that time,) it doing so at fixed places having a pebbly bottom, where springs gush up from the earth. At all other times it is difficult to catch. The hatching of the impregnated ova is easily accomplished. The young fry are placed in small ponds with gravelly bottoms, with a moderate supply of spring water having a temperature of 5° to 8° Reaumur, = 43° to 50° Fahrenheit. Here they live together in shoals. So they remain, only rising to a small distance from the bottom when they are from four to six weeks old, ascending towards the spring, as fresh cold water is essential to their existence. Here they find their nourishment without difficulty. It is only after a period of three to four years that they are bold enough to attack minnows and other small, harmless fish. Their first and most favorite food is their own spawn, and the small fry of their own species. It is a fortunate circumstance that during the spawning season fish lose their appetite. Another protection to the ova is, that they are mostly deposited among large, sharp-edged stones.

In artificial breeding ponds young salmon are easily fed upon the tender spawn of carp or tench, pounded white fish or horse flesh, &c. In large lakes they find sufficient food naturally.

It is, therefore, to be remarked, that for the successful rearing of salmon three things are necessary:

1st. A clear, cold, running stream; temperature from 5° to 7° and even 8° Reaumur, (43–48°, even 50° Fahrenheit.)

2d. The draining of the canal or pond, in order to clear it effectually of other fish.

3d. For trout, large space, according to the number, canals of at least a mile and a half in length.

It would form a most important point for every government to enact laws prohibiting the taking of fish during the spawning season, excepting for the purpose of artificial propagation. France takes the lead of all other European goverments in further to the utmost this branch of domestic economy; after her the various Agricultural Societies of Bavaria, and in England private individual enterprise.

The French government appropriated 100,000 francs towards founding an establishment at Hüningue; besides which there are others, chiefly one at Versailles, near Paris. It caused the works of Monsieur Coste, the embryologist and icthyologist, to be printed and circulated; it distributed decorations amongst competitors, and sent out travellers over Europe to collect ova.

In Bavaria the Agricultural Society established various stations, all connected with the Central establishment at Munich. There is one for the lake salmon at Standach, on the Chiem See; another for all species of salmon at Augsburg; another at Landshut, under the care of Dr. Wimmer, for the Salmo Aucho or huck, and other kinds; another at Schleissheim for summer-spawning fishes, making use of the water of the Würm; another in Lower Franconia, under the charge of Major List. The fishermen in charge of these establishments, as also the author of these Notes, visit the different stations for interchange of information and experience.

The ova are sent from the Central Station at Munich as far as Warsaw, Königsberg, Mecklenburg, Rhenish Prussia, Gallicia, Hungary, and Carinthia, and people wishing to be instructed in the art come from all parts of Germany, even from Hanover, the cradle of the original discovery.

The gentleman in charge of the establishment at Munich, who formerly was paid by the Agricultural Association, now conducts the same on his own account with profit. During the year from October, 1855, to October, 1856, he forwarded over 200,000 ova of salmon. It may be here remarked that the ova of salmon are large—often as large as peas—although not so numerous as in other fish. It would, therefore, be improper to speak of them by millions, excepting the single instance of the large Rhine salmon, (Salmo Salar,) when caught in very great numbers. We can only speak of millions of ova when referring to the small roe of summer-spawning fishes; for instance, a middling sized carp may contain 150,000; but of these the number of really hatched ova can only be guessed at, not counted.

Among the important facts ascertained last year the most important one is, that the three years old trout and salmon trout are themselves fruitful, having both milt and roe perfectly developed. Those that have been artificially fed have increased greatly in bulk and weight, more so than if they had been left in their normal state.

An experiment was made to rear the fry of trout in narrow spaces with artificial food, but it did not succeed. They strive to live separate, and die in quantities when compelled to congregate together. The same happened with lake salmon. Graylings and the Huck, Salmo Hucho, require still larger space, together with a very rapid current; but with the Salmo Umbla we succeeded. With pike and tench the success was still more certain. They must, however, be separated from each other, and the water needs to be of a higher temperature.

The science of Pisciculture having been proved to be both practicable and profitable, new establishments are being formed all over the country. One of the chief subjects yet to be studied is the habits of each individual species, both in its natural and artificial states. Another subject for inquiry will be the cost of materials to be given as food, as upon this, in a great measure, will depend the ratio of profit to be derived from the pursuit.

MUNICH, *October*, 1860.

Extract of Report of the results of Pisciculture in Bavaria for the year 1855, 1856, *derived from the Archives of the Agricultural Society of Upper Bavaria. Condensed and translated from the original German.*

80,920 partly three months' old fish, partly matured embryos, were distributed. They were of the varieties Salmo Umbla, S. Fario, S. Salar, S. Hucho, S. Lacustris, S. Trutta, and Esoxlucius. Among them were some 8,000 Rhine salmon, from the establishment of Hüningue, France. In exchange we sent to Paris 6,000 embryos of S. hucho, 2,000 of S. Umbla. Of the result of these we have learned the following: 3,000 Rhine salmon were placed by order of the Directors in the river Würm, and 2,000 in the Starnberger-See. Dr. Stephan placed also a number in some ponds belonging to him, and some in the Amper; 1,000 were placed in the fish preserves of Prince Charles of Bavaria, and 500 in the Tsar. Only Dr. Stephan reports that his fish are in good condition. From the others we could ascertain nothing; but it must be remembered that the salmon has migratory habits, and returns regularly to his old haunts. * * * The artificial propagation of that most delicious fish, the Salmo Umbla, has proved extremely easy this year, and that of the trout not less so. From various accounts the trout artificially produced, and afterwards transferred to larger waters, have remained for a year in the most perfect condition. On the estate of Baron Von Wendland, of Baerenried, in a small newly constructed pond, fed by a trout stream, there are now some 500 small thriving trout, bred and reared by himself. Also, about 8,000 in the preserves of his Royal Highness Prince Karl, of Bavaria. Baron Von Schaky, of Bruckberg, also procured trout of six inches long during the first year from embryo sent him. In the waste-water conduit belonging to the Royal Veterinary College, where no trace whatever of fish was known to exist, a few of the small fry happened to slip in at the hatching season. We examined this diminutive channel also at the expiration of a year, and found, with the aid of a very fine-meshed net, over 200 trout from three to four inches long that appeared to be well fed. This is a convincing proof how many nutritious substances were contained even in this small ditch, measuring some sixty yards long, about three to four feet wide, with a depth of at most one foot, as these fish were not artificially fed. Besides this, a large number of small trout were caught by children at the yearly cleansing of the canal into which the breeding stream empties itself. * * * The lakes of Upper Bavaria are remarkable also for the Salmo lacustris, var. argentea and S. Trutta, both of which are scarcely inferior to the salmon of the Rhine; the first attaining a weight of upwards of 40 pounds. The last-named species is found but rarely in all our lakes. The first named is still less frequently met with, and only the Chiem See has a remunerative fishery at Maquartstein, on the river Achen. The fishery is royal property, and the fisher-

men compelled to use nets with wide meshes. But for this regulation the name "Salmon Fishery" would become here, as it already has in many places in Germany, a mere matter of history, on account of the numerous poachers who kill the fish with the spear. Leaving this out of account, still the lake has diminished of late, owing to the fact that most of the fish, in their progress up stream, are caught *before* the ova have arrived at maturity, and *before* they begin to spawn. It would be more desirable if the fishermen would wait till the fish had reached shallow water, but then it would also be easier for poachers to spear them. * * * * * * * *

The District Committee of Upper Bavaria has entertained the proposition of the Departmental Council to recommend several improvements in various matters, and it is to be hoped that by means of artificial propagation, and protected by adequate laws, those Bavarian lakes adapted to the purpose, as also the Chiemsee, may be so stocked and replenished as to render "Salmon Fishery" once more a reality. Some thousands of these species were placed in the Wurmsee in the spring. In the year 1856 there were about 10,000 in the breeding canal. Instruction was given at Maquartstein, and with the assistance of the gamekeeper a depot for Rhine salmon will also be established. The fishermen have been examined in the practical knowledge of the fructification and transportation of the Ova.

An attempt to transport the fry of the Salmo Hucho, from the Maine, Rhine, and their tributaries, to the waters of Bavaria, situated in Franconia and the Palatinate, where it does not exist, did not succeed, for the reason that the ova of the fish, when the embryos are three to four weeks old, (the age when best adapted for transportation,) are exceedingly delicate, the outside skin of the ova being so thin as to rupture with the lightest manipulation or pressure, a circumstance hitherto unknown to us. In future the removal must take place at an earlier period, which is no detriment, as proved by those sent to Paris.

A renewed attempt to propagate the Lucioperca Sandra by artificial means in the Ammersee did not succeed, although the attempt received the assistance of Baron von Perfall, of Graefenberg. It is almost in vain to hope for success; the ova of this fish being so tender, their vitality so small, and the maturity of the spawn of such short duration. A favorable result can only be obtained by patient and attentive local investigation.

The propagation of the Renke succeeded, as also of the transportation of the Blaufellchen (little blue skin) from the Bodensee to the Sternbergersee, by means of ova already far advanced in the process of hatching.

Now, although the fact is established, partly through our own experiments as by those of physiologists, that the artificial fructification of fishes is a universal, practical, and successful process, yet with certain species it appears to be attended with so many obstacles of an economical nature, such as the catching of the female, the short duration of the spawning season, susceptibility to changes of temperature, risk of transportation, &c., &c., that as a remunerative pursuit it can scarcely be recommended. On the other hand, other species multiply so greatly in their natural state without any care, as the carp and pike; others again, as the Leuciscus, are of so little value as an article of food, as to render Pisciculture superfluous, or, at all events, the trouble of breeding and rearing is not repaid. For these, in most cases, artificial impregnation alone will suffice, the remainder being left to Nature. It is only with the more valuable species, whose natural increase is inconsiderable when compared with other fresh water fishes, that artificial propagation and tending plays a most important part.

Our experience during the second year of our experiments has shown us, that not only a large number of the superior description of fishes can be bred and reared artificially with great ease and at little expense, but also, and this is the main point, that when left to themselves they thrive, increase in bulk, and exist in great numbers in comparatively small extent of water. It is just in small spaces that one can form a correct idea of the feasibility of the experiment.

No doubt remains, after the late trials of the General Committee of the Agricultural Society of Bavaria, as also of the various Piscicultural establishments in France and England, that in artificial propagation, particularly of fish, an exceedingly valuable article for the subsistence of man has been developed from comparatively worthless sources. Man has thus acquired the power of rendering innocuous many influences detrimental to the increase of fish, such as steam-navigation, water-works, and other inventions relating to his own industrial progress, and in the science of Pisciculture offers an equivalent to the loss resulting from these.

A great number of farmers, owners of fisheries, and other friends of this branch of industry have taken up the matter and are prosecuting it with success. The chief point of the Committee—instructive and encouraging to persevere—has been attained, and it reflects no little honor on our country that she has taken up this branch of industrial economy so speedily and made it her own before all other German States. She is, however, blessed with numerous fishing waters, noble species of fish, and not least, with a people peculiarly

adapted to the pursuit. We count in all districts several practical fish-breeders. Nothing is wanting but patience (a virtue that appears gradually to diminish from amongst us) and progress in practice, in order to reap the greatest benefit from the discovery.

As Pisciculture may therefore be looked upon as domiciled among us, the following points may be regarded as desirable for the future:

That each government shall agree to respect the recommendations made last year to introduce or more effectually carry out the ordinances regarding the fisheries. To enforce the same through the courts of law, and at the same time to move for the support of the five following regulations as indispensable:

1. Distribution of fishing licenses by the proper authorities, countersigned by the Royal officers of Police; without such licenses no person to be permitted to fish.
2. The establishment of a fixed time of closure at least one month during the spawning season of each species of fish, excepting such as it may be desirable to catch for artificial propagation during that period.
3. The establishment of a fixed standard of weight and size, under which no fish may be legally exposed for sale.
4. Prohibition to catch fish during winter in the old channels of the rivers.
5. Permission to extirpate all animals destructive to fish.

The regulations should, however, be so framed as to assimilate with any ordinances already promulgated.

The assistance of the Fishery Club about to be established amongst us should be requested, in order to establish the above fundamental principles. The active co-operation of all the Upper Provinces of Bavaria, Swabia, Upper Palatinate, and Lower Franconia, should also be invited, as with the exception of the Upper Palatinate, (particularly the Bavarian and Bohemian forests,) the other three Provinces have already their own Central Institutions, (namely, the Royal Veterinary College here; the licensed town fisherman, Scheufelhut, in Augsburg, and Major List, in Wurzburg.) An advance of four hundred florins to Swabia and Lower Franconia would greatly facilitate the next undertaking. The District Committee of Upper Bavaria has already agreed to support Pisciculture in the various lakes, particularly the Eibsee, with an adequate appropriation.

The Committee having concluded to transfer the management of the Fish-breeding establishment of the Royal Central Veterinary College to the sole care of Mr. T. B. Kuffer from January, 1856, and having fixed a certain tariff for the artificial fry, this, now private, establishment deserves support. The stipulated interchange with the French Imperial establishments at Hüningue and Paris are to be continued.

The creation of a separate Establishment at Maquartstein for the propagation of the salmon of the Gemsee in the lakes of Upper Bavaria is considered important, as also that of salmon on the Walchensee. The District Committee is requested also to support, in the Establishments of Upper Bavaria and the Palatinate, the propagation of the Salmo Umbla, and the continuation of the experiments with the salmon of the Rhine; also the transfer of the Salmo Hucho to the waters of Franconia, and the continuation of the experiments with the ova of summer spawning fishes—that of the Amäul—in the waters adapted to that purpose at Schliessheim, and finally the experiments with artificial rearing and feeding of fish artificially propagated. The Commission is enjoined to continue its support, as without perseverance in this branch of industry it must fail. The distribution of prizes among successful competitors is also recommended.

The Committee is happy to announce the formation of two Fishery Clubs, one at Munich, the other at Fischheim, the members of which belonging to the higher classes of society, exert all their influence for the advancement of this interesting and important enterprize.

The General Committee finally promise their co-operation in a work, which at present can be conducted with comparatively small outlay with the prospect of great success.

DR. FRAAS.

Extract of Report of T. B. Kuffer, Manager of the Piscicultural Establisnment at Munich, of the results during the Spawning Season, 1857–'58, *addressed to the General Committee of the Agricultural Association of Upper Bavaria.*

The Committee, seeing the importance of catching salmon of the Chiemsee, for the purpose of procuring spawn, ordered the undersigned to proceed to the lake in the fall of 1856. Whilst there he constructed an oaken box to contain the fish, placing it in one of the tributary streams of the river Achen, which river the salmon ascend during the spawning season. The box was constructed so as to contain breeding pans, in order that in this sheltered spot the process of fructification and hatching of the ova might take place undisturbed. The

experiment succeeded admirably, and the hatching was accomplished with comparatively small loss.

In order to continue the operations commenced by the Agricultural Society I went last autumn, at my own expense, to Maquartstein, where I arrived on the 4th October, and commenced fishing for salmon, assisted by the fishermen of Feldweis; we caught but few, and I soon ascertained the reason, namely, that the river Achen, near its confluence with the Chiemsee, was staked with no less than eighteen nets, in the neighborhood of Grabenstaedt, through which but few fish could pass, and that with great difficulty. Those that had passed, and had been captured at Maquartstein, showed evidences of their violent struggles to pass upward, in the circular depressions round their bodies. When caught they were seldom found fit for the purposes of propagation. These nets were of such illegal dimensions of mesh that fish even of two pounds weight were caught by them. This method of fishing is perhaps the very best that can be adopted to extirpate entirely this delicious fish. Having caused the removal of these obstructions, the salmon caught subsequently were in good condition, apparently just from the lake, and adapted to my purpose. We caught in all some thirty fish, which were placed in the repository, and from them I obtained about 40,000 ova, which I impregnated and placed in the box to hatch. About 7,000 were kept for depositing in the river Achen; but the embryos not being fully developed by the 10th of November, they were left under the charge of a fisherman. The remainder of the ova I packed in moss and sent to Munich without damage. Here some of the ova remained till they had attained a more favorable stage for transportation; others were completely hatched, in order to be distributed into the interior. During my stay at the Chiemsee the fishermen there evinced an increasing interest in the science of Pisciculture, were very observant of the manner in which I manipulated the fish, as also of the general rules and advantages of my method.

Extract of the Report of T. B. Kuffer, Manager of the Piscicultural Establishment at Munich, from October, 1857, *to April*, 1858.

The number of ova ordered amounts to 700,000, that of ova delivered to 360,000, so that only about one-half of the orders could be executed. The greatest demand was for the ova of the Salmo Umbla; after these, of the trout, and then of the salmon trout. Exchanges of ova with foreign States were effected as agreed upon.

From France I received Rhine salmon; from Hanover, Elbe salmon; against which I exchanged ova of the trout and Salmo Hucho.

During a period of three years the French had attempted the hatching of the ova of the S. Hucho without success; at last I was invited to superintend the process personally. This I did with complete success. The remainder of our ova was distributed over Bavaria, with the requisite instructions, drawings of apparatus, and specimens of the breeding pans.

The design of the breeding box was that of Dr. Wimmer; the directions those of Dr. Fraas's work, "Anleitung über künstliche Fischzucht," (An Introduction to artificial Fish-breeding.) Most favorable accounts have been received, even from the remotest places, of the arrival of the ova in good condition. Experience has proved that packing the ova in damp moss is the best method. *A most important fact has been discovered relative to the proper time at which the ova are best adapted for transportation*—several trials having proved that the period of fourteen days, prior to the development or final bursting of the pellicle of the ovum, is the best adapted to that purpose, with the exception of the S. Hucho. The reason is, that at a later period the pellicle becomes so thin and tender that it is easily ruptured by the slightest manipulation.

Some ova have greater powers of vitality or endurance than others; for instance, I found ova of the salmon which had fallen by accident into some damp moss; in these the development of the ova was nearly completed.

Although the results of Pisciculture are as yet unimportant, yet it cannot be denied that without it the ova of fish exposed for sale in the markets, or otherwise lost or consumed, would be entirely lost for breeding purposes.

We have hitherto occupied ourselves with only the first and less important part of the problem, that of production. For the second *and most important, the rearing of the fish,* we have as yet done nothing, as we lack the necessary requirements—artificial ponds, &c. Even in France, where a sum of 100,000 francs was annually expended on the establishment at Hüningue, they did not succeed until they had constructed artificial ponds, in which to rear the young fish. I may finally add that Baron von Washington, in Styria, has commissioned me to establish on two of his estates breeding canals and rearing ponds upon an extensive scale.

Extract of the Report of T. B. Kuffer, Manager of the Piscicultural Establishment at Munich, of the results during 1858–'59, *addressed to the Committee of the Agricultural Association.*

The most important feature I have to bring to the notice of the committee is the acquisition of a piece of property eligibly situated, having running springs of water of suitable temperature and abundant supply, so as to enable me to prosecute Pisciculture with renewed success, and extend the art to the *rearing* of fish. There are two springs of water, temperature six to eight Reaumur. These discharge themselves into two ponds, to which I have lately added a third.

For the development of the ova I constructed a canal eleven feet long by one foot broad, in the direction of north and south, into which the ova of the winter spawning were hatched with but insignificant loss. A considerable addition to this canal will be rendered necessary during the ensuing season, as it must serve for the retreat of the young fry during the first year.

I will now touch upon the subject of winter spawning, under three separate heads:

1st. I can report nothing regarding lake salmon, as all the specimens caught were dead.

2d. The spawn of the smaller species of "Salmo" was hatched successfully in the locality above named, with a loss of not more than one-fifth of the ova. I have ascertained by actual experiment the important fact that the ova must not be placed in the immediate vicinity of the spring, but in the canal, where the water, after exposure to atmospheric influences, has acquired some property better adapted to the support of life. A large number of the ova were sent to various parts after hatching during five weeks with the most satisfactory results, as the change of locality and temperature do not appear to have affected the young fish. During the season at least 220,000 ova were hatched, one-fifth being of the Salmo Umbla, and of the Trout and Salmon trout each two-fifths. In addition to these some thousands of a bastard or mule breed were produced from the milt of the Salmo Umbla and the roe of the trout. These have thriven remarkably well, have developed themselves rapidly, and continue healthy and lively. At one time I suddenly missed large numbers of my small family, and eventually discovered that a water mouse had committed sad havoc among them.

3d. Of the Salmo Hucho I did not succeed in procuring a single living specimen, as the fishermen are in the habit of spearing this species. Dr. Wimmer, of Landshut, offered me the whole of his stock, consisting of some 8,000 ova. This offer I was compelled to decline, as I considered them too far advanced in the process of hatching for safe and successful transportation.

History and Statistics concerning Pisciculture in Bavaria, extracted from the publication, "Notes on Rural Economy," published in Bavaria.

Although great attention has been bestowed on raising and improving the condition and quality of domestic animals attached to the habitations of man, there has been an evident and blameable neglect in reference to the oviparous tribes, as bees, fish, leeches, silk worms, and lastly, poultry.

The possibility of cultivating them to a high degree of perfection has been successfully tested by the late introduction of artificial means for the propagation of fish. It is most important, however, to ascertain the different sorts of treatment required by the different classes, more especially those of the carnivorous order, which are more difficult to rear in considerable numbers.

Artificial fish-breeding dates back to the eighteenth century, when it was first practiced by Captain S. L. Jacobi, an officer in the service of the Duchy of Lippe, who, however, is said to have derived his information from an old experienced fisherman who had reduced to practice the suggestions of his vocation. It is possible that Jacobi, during his fishing rambles, availed himself of these to improve his knowledge by personal observation of the habits of the trout, which, seeking pebbly bottoms, deposits its spawn in the holes found there. The idea of domesticating this desirable fish was, no doubt, effected eventually, and the results communicated to the Hanoverian Magazine in 1763, which gives Jacobi the credit of being the discoverer. In the following year, 1764, Gleditsch also made a communication on the subject to the Academy of Berlin. Naturalists immediately manifested great interest in the subject, and published treatises promoting the science of embryology, but doing little to promote the practical development of it. For a season Jacobi's discovery, with all its interesting facts, was all but forgotten. In the Duchies of Lippe and Coburg alone it continued to be practiced without interruption. Besides this we hear little of the art excepting its adoption in a few places in France and Scotland from the years 1830 to 1848.

Since the year 1848 an improved method was introduced into France by Remy, and sustained by Quatrefages, of Paris, and from thence it found its way to Germany, its birthplace.

The Committee on Rural Economy, in Bavaria, ordered the establishment of an Experimental pond in the Veterinary College at Munich, where practical fishermen and amateurs were privileged to receive the instruction essential to the success of the business. The same association founded other Experimental Schools in aid of the cause, and in course of time fishery clubs were instituted, and the experiments and their results were published for the information of the public. Prizes were also distributed among successful competitors; in short, all laudable efforts were made to cherish and extend this interesting branch of Rural Economy in Bavaria.

In France great attention has been bestowed on the subject, and the Coste plan acted upon, without, however, realizing the extravagant hopes of its friends. In the oldest Establishment at Munich the same results have been experienced. The system of raising fish in vast numbers has been abandoned, and the method of liberating the young fry, after the disappearance of the abdominal chord, has been successfully substituted.

It is a matter of regret that so much ignorance exists in regard to the raising of fish to advantage. One great reason of failure is the want of requisite knowledge in regard to the quality of food given to be consumed. Experiments have proved that barely ten per cent. of young fish can be reared from ova. They seem to thrive, and usually can be kept at least two or three months after they part with the membrane; but, after that, all the food that can be given, and which they seem to devour so voraciously, is found to be by no means equal in its effect as that procured naturally, and it is the province of the icthyologist to discover the best sort of food, if any be required; but unfortunately, so far, we have only been favored with their sanction to the discoveries made by practical men. Although it is certain that a great number of the fish artificially reared live after being set at liberty, yet it is equally certain that a still larger number die, and that the survivors do not repay the cost and trouble incurred. It is, therefore, natural that we should fall back upon the original scheme of raising fish artificially in inclosed spaces, and a system of ponds and streams can certainly be constructed to this end. It is also absolutely necessary to let the water be drained off, if only for a short time, in order to destroy the natural enemies of the fish. At least a year previous to the introduction of the fish into the ponds or streams, it will be necessary to plant them with water-plants for their nourishment and protection. These plants harbor myriads of the ova and larvæ of insects, molluscs, &c., all of them forming the natural food of fish. From experiments made, the best sort of artificial food for the one year old fry consists of blood, liver, fish roe, and pounded fish. With such food about thirty pounds of trout were raised during three years in a pond of only two hundred feet superficial area.

In adopting these suggestions for the use of those desirous of entering into the enterprise, we look forward to some good practical result; otherwise we can only look for but middling success, as past experience has abundantly shown.

We subjoin a catalogue, showing all the elements for artificial fish-breeding, originating with Dr. Fraas, but improved by Kauffmann.

Spawning.

1. NAMES. Latin.	German.	English.	2. Time of spawning.	3. Water.	4. Ground.	5. Temperature of water.	Time required by ova for development.	Difference in the period of spawning.
Esox Lucius	Hecht	Pike	P. New Year and March till April.	Quiet shallow rivers	Mud, plants, roots	8.12° C. 47.54° F.	14 to 26 days.	V., February and March.
Lucioperca Sandra	Sander	Sandling	New Year and March till April.	Easy flow and quiet.	Sand, gravel, deep inland lakes, steep banks.	6.12 C. 43.54 F.	Unknown ...	C., F., S., V., April and May.
Acerina cernua	Kaulbarsch	Chubb	March and April.	Flowing	Mud and sand	8.10 C. 47.50 F.	15 to 20 days.	......
Petromyzon fluviatilis.	Neunauge	Lamprey	......	......	......	......	......	......
Thymallus vexillifer	......	......	March to May	Heavy flow	Sand and gravel	8.12 C. 47.54 F.	30 to 36 days.	......
Salmo Epelanus	Stint	Smelt	April	Flowing & sea shore	......do......	8.10 C. 47.50 F.	5 to 10 days.	......
Perca fluviatilis	Barsch	Perch	April	Quiet or standing	Plants and roots	8.12 C. 47.54 F.	8 to 14 days.	S., March to May; V., April and May.
Cyprinus Erythroph	Plötze	Bleak	End of April	......do......	..... do......	10.12 C. 50.54 F.	5 to 10 days.	......
Alosa vulgaris	Maifisch	Shad	April to May	Flowing	Sand and gravel	10.12 C. 50.54 F.	20 to 25 days.	According to V ......
Cyprinus Brama	Brassen	Bream	May	Quiet or standing	Plants and roots, seldom sand.	10.12 C. 50.54 F.	8 to 10 days.	......
Cyprinus barbus	Barbe	Barbel	May	Shallow rapid flow.	Sand and gravel	8.10 C. 47.50 F.	10 to 15 days.	......
Cyprinus Crassius	Karausche	Bastard Carp	May and June	Quiet or standing	Plants and roots	16.20 C. 61.68 F.	6 to 8 days.	S., 2 weeks; V., 3 weeks, development.
Cyprinus Carpio	Karpfen	Carp	May and June	......do......	......do......	16.20 C. 61.68 F.	......	......
Silurus Glanis	Wels	Shad	May and June	......	......	......	......	......
Cobitis barbatula	Grundel, Schmule	Groundling	May to June	......	......	......	......	......
Gobio fluviatilis	......do.	.....do	May to September	......	......	......	......	......
Cyprinus Tinca	Schleihe	Tench	June and July	Quiet or standing	Roots	18.25 C. 64.77 F.	6 to 7 days.	S., April, June......
Salmo Hucho	Huchen	Huck	April to June	Rapid flow	Sand and gravel	5.7 C. 41.45 F.	......	......
Salmo Fario	Bachforelle	Brook Trout	Sept. to Nov.	Flowing	Gravel	5.8 C. 41.47 F.	......	......

Corregonus lavaretus	Gangfisch	Salmon Trout	do.	Calm	Sea shore, sand	In the hatching apparatus at a temperature of 5.8 C. 41.47 F. and darkness. At a temperature of 10.12 C. 50.54 F. admitting light of the sun.		
Salmo lacustris	Salmon, Lachs	Salmon	Sept. to October.	Heavy flow	Gravel			C., November, February.
Salmo Salar	Saibling	do.	Oct. to January	do.	Sand and gravel			S., October, January
Salmo salvelinus	Salmling	Red Charr	do.	Rather heavy flow	do.			
Salmo Trutta	Lachsforelle	Salmon Trout	Nov. and Dec.	Flowing	do.			S., October, December.
Corregonus fera	Bodenrenke		do.	do.	Deep lakes			
Corregonus maraena	Maraene		do.	Quiet	Sea shore, sand			F., Spring
Corregonus palea	Balchen		do.	Quiet	do.			
Salmo Umbla	Ritter, Schar	Charr	Dec. and Feb.	Quiet	Sea shore, gravel.			F., December, March
Gadus lolt	Quappe		Christmas and N. Year.	In the midst of flowing water the spawn is washed off.				

The initials V., C., F., S., are those of Vogt, Coste, Fraas, and Scheven.

INSECTS INJURIOUS TO VEGETATION.

BY P. R. UHLER, BALTIMORE, MD.

During some years particular sections of our country are visited by certain species of insects, and whole crops of the most valuable productions of the soil are consumed or rendered worthless. Millions of dollars worth of the fruits of vegetable life are annually sacrificed by insects. Their ravages upon our field crops, fruits, garden products and forest trees have been remarked in all parts of the country, and numerous and loud are the complaints continually made against them, and every returning season seems to add to the number of hurtful species.

Before the appearance of Dr. Harris's work in 1841 almost nothing had been done in this department. A few small papers, scattered through the various agricultural and other periodicals, had appeared, but no full and satisfactory history of our common predatory insects had been given, and no extended work upon the subject had been published. This volume, entitled "A Treatise upon some of the Insects of New England which are injurious to Vegetation," contains descriptions and as far as was possible the complete history of a large number of the species of insects which were known at that time to be destructive to vegetation in New England. Dr. Harris had previously written separate articles upon various hurtful species which had come under his observation, but in the work just noticed he has embodied all that he had previously written, and added such new facts as had been elicited up to that time. The book recommends itself to the consideration of the agricultural reader as the best which has appeared upon the subjects of which it treats, and it is one of the first which is usually placed in the hands of the student who wishes to become conversant with the Entomology of this country. Its nice discrimination and precise accuracy reflect the highest credit upon the untiring energy of the man who wrote it, and its publication does honor to the State under whose patronage it was published.

In 1852 another edition was issued, still more complete and useful, both by increase and further revision.*

It is not intended to record in this place the writings of all the other eminent men who have distinguished themselves in the department of Entomology, excepting the illustrious Say. Their attention was mostly directed to the philosophic or descriptive portion of the science, and they have enriched and embellished it to the utmost of their abilities. Our attention must rather be directed to that practical portion which addresses itself more immediately to the physical necessities of man.†

INSECTS INJURIOUS TO FRUIT TREES.

I. PEAR.

Doubtless many insects will yet be found destructive to the Pear, but until now very few have been noticed, and most of them will also be found upon the Apple.

1. A species of *Coccus* (Bark-louse) has been noticed by Dr. Harris to be very abundant upon the bark of this tree, but as he had no opportunity of examining living specimens, its history remains incomplete. He regards it as similar to a species common upon the aspen in Sweden, called *Aspidiotus cryptogamus*, Dalman. It may be characterized as follows: there are two forms, the one about the tenth of an inch long, shaped somewhat like an oyster, tapering towards the front, and broad at the posterior extremity, the front surmounted by a little oval brownish scale. The other, not more than half the length of the first, is of a very long oval shape, or almost four-sided, with the ends rounded, and one extremity is also covered by a minute oval dark-colored scale.

* Another edition of this most excellent work is now passing through the press, which is to be embellished with a number of fine colored plates and woodcuts, at last fulfilling the desires which had been so frequently expressed in behalf of a still more extended field of usefulness for it.

† It should be remarked that the observations recorded in this paper are chiefly drawn from the works of Doctors Harris and Fitch, and such others as seemed of greatest merit. And with these a few only of my own observations and experiences are included, not having intended to offer new facts, but rather to bring together in a small compass so much of what has been recorded as may seem sufficient to present the subjects in a clearer and less difficult manner.

"These shell-like bodies are clustered together in great numbers, are of a white color and membranous texture, and serve as cocoons to shelter the insects while they are undergoing their transformations. The large ones are the pupa cases, or cocoons of the females, beneath which she lays her eggs, and the small ones are the cases of the males. They differ from the females not only in size and shape, but also in being of a purer white color, and in having an elevated ridge passing down the middle. The minute oval dark-colored scales on the ends of these white cases are the skins of the lice while they were in the young or larva state."

The white scales themselves are probably a secretion, which becomes dry and hard by the contact of the air, and thus constitutes an important shelter for them. The male undergoes his transformations, quits the scale which he formerly inhabited, and flies about—an almost imperceptible atom—in quest of the female. The female, after impregnation, deposits her eggs beneath the case, which she never quits, after which she dies and shrivels up, thus allowing more room for the increasing size of the developing eggs. After exclusion and sufficient maturation, the larvæ quit the case by the slit-like aperture in the end, and fix themselves securely to the bark by means of their sharp, slender beak, and those of them which are females remain so attached during the rest of their lives. The damage effected by these insects is brought about by the continual drain upon the vital resources of the tree in having the juices extracted by means of their sharp beaks. When their numbers are very great a tree may soon fall a victim to their voracity. Each individual requires a large amount of nourishment, and that, too, during a considerable period of time. The leaves of a tree attacked by them will soon appear of a sickly yellowish hue, and fall off, and if their depredations are not quelled before this time there is but a poor chance left for its recovery. I am not aware of any extensive injury having yet been effected by this species, but it behooves nurserymen and cultivators of the pear to be on the lookout for it, for when a species of this kind becomes fairly seated in an orchard it is exceedingly difficult to eradicate.

2. Another species of Bark-louse, *Lecanium Pyri*, Schrank? is stated by Dr. Fitch to infect the limbs of the pear tree. (See Trans. N. Y. Agricul. Soc., 1854, p. 809; also, Report, &c., 1856, p. 105.) "It resembles a hemispherical scale, about twenty-hundredths of an inch in diameter, of a chestnut-brown color, wrinkled towards the edges, and sometimes pitted over with shallow round impressions, such as might be made with the head of a pin. They adhere to the bark on the under sides of the limbs, particularly of young trees which are growing thriftily." These scales are of the same nature as those noticed in the preceding species, and are found to be chiefly females.

The scale of the dead female shelters the eggs, but in this species there is a cottony secretion beneath it, amongst which the young lice will be found. Cottony matter increases in volume and elevates the scale, allowing the young lice to escape. After leaving the maternal shelter the young lice scatter over the smooth bark, and fasten themselves securely by inserting their sharp beaks into its substance. At first they are very minute, resembling whitish specks, and when placed beneath the lens they are found to have six legs and two short antennæ, or feelers, projecting like small threads from the head. The length of these organs may be about one-fourth of that of the body, and they are clothed with a few fine hairs.

Like most of the insects of this family, the legs of the young developing female are finally lost in the increasing growth of the scale. The scales, when rubbed off or picked from the bark, leave a whitish spot, just of the size and outline form of the scale which covered it. In all probability these insects conform to the habits of their congeners, laying their eggs during the warm weather of summer, and continuing, though in a less rapid degree, their development through the rigor of winter, and disclosing the perfect insects in the spring.

3. *Aspidiotus furfurus* is the name of a third species of bark-louse, found parasitic upon the limbs of the pear. (See Trans. N. Y., &c., 1856, 352, No. 54.) They are "little round or oval white wax-like blisters on the smooth bark." The history of this species is probably not yet completed; but the characteristics given by Dr. Fitch, of the eggs and location of this insect, would lead us to infer that it is similar in nature to the other species, whose history is better known. He says: "The bark of the limb was covered with an exceedingly thin gray film, appearing as though it had been coated over with varnish, which had dried and cracked and was peeling off in small irregular flakes, forming a kind of scurf or dandruff upon the bark. In places this pellicle was more thick and firm, and elevated into blister-like spots of a white color and waxy appearance, of a circular or broad oval form, less than one-tenth of an inch in diameter, abruptly drawn out into a little point at one end, which point was stained of a pale yellow color, and commonly turned more or less to one side. The spots when broken open disclosed a considerable number of exceedingly minute oval eggs of a bright purple color and glossy. It is probable that these eggs produce larvæ so minute as to be invisible to the unassisted eye." Should such be the case, myriads of these

minute creatures would spread themselves about upon the bark and commit the most extensive depredations without our being able to see the cause. The most probable time for applying a remedy would seem to be a short time after the young have emerged from the egg. This would appear to be the proper time for attacking all the insects of this nature; for when they are young, exposed, and more sensitive to external agencies, any means applied that might be used extensively enough and with great care to leave no fissures untouched, would be much more efficient than when the dry, hard scale covers the female or protects the young. Possibly the early part of autumn would be the best time for applying any remedies which might be suggested, as that would probably be the time when the summer brood is hatched and passes from the maternal shelter.

Nature has provided a parasite for most of these species, and thereby displays a wonderful provision for keeping their numbers in check. These parasites deposit an egg within the scale of the female, which produces a very small maggot that feeds upon her substance and destroys her life. After completing its transformations it perforates a hole through the dry, dead scale, and comes forth a perfect winged insect, capable of reproducing its kind and rendering still greater assistance in destroying a larger number of these lice.

Remedies.—The best remedy which has yet been tried is made by boiling leaf-tobacco in strong lye until it is reduced to an impalpable pulp, (which may be effected in a short time,) and mixing it with cold-made soft-soap until it appears of the consistence of thin paint. This must be applied before the buds have swollen in the spring, and its efficiency will be increased by trimming the trees and applying the mixture over the whole of the bark. With those species which confine themselves to the limbs, it will be necessary to coat the entire surface of those parts, so as to include every crevice and place of shelter likely to be occupied by them. A greatly desirable object is attained with this mixture, in the fact of its not being readily washed from the tree by the rains. Tar and linseed oil beat together, and applied warm with a brush, forms a sort of varnish-like coating which peels off, bringing the dead scales with it; this may also be applied before the bursting of the buds takes place. To destroy the whole young brood the latter application might be used directly after the fall of the leaf. Strong soap-suds applied when the lice are young has proved very efficient in some instances; it must be rubbed on profusely with a brush. Potash-water, whitewash, dry ashes, and sulphur, have been recommended, but not much is yet known concerning their efficiency.

The plum-weevil, *Conotrachelus Nenuphar*, makes small crescent-shaped incisions in the smooth bark of the limbs, wherein will be found small, whitish maggots; but as this species does such extensive injury to plum trees, it will be more properly considered under the subject of that tree.

The Pear Chermes, *Psylla Pyri*, has at length been found in this country; for a number of years it had been well known in Europe, and it is probably the case that it has been imported from thence. It is a small orange-yellow insect, greenish upon the abdomen and about one-tenth of an inch long; the wings are delicate and semi-transparent, with yellowish nervures. It punctures the smaller limbs and twigs with its sharp, slender beak, which appears situated near the middle of the body beneath, causing the bark to turn rusty blackish, and by continually drawing the sap, it eventually destroys the tree. In form, it somewhat resembles the ordinary plant-lice, but the head is relatively much larger, the body decreasing in size posteriorly, the legs short and more robust, and the wings rest obliquely upon the abdomen like the roof of a house. It possesses a great facility in leaping, and generally lives in small companies of a dozen or more individuals upon the twigs and stems, and often upon the leaves. The females are provided with a sharp awl-like instrument at their hinder extremity, with which they pierce the buds and leaves, and therein deposit their eggs. This operation often gives rise to small swellings or excrescences, which serve as indications of places affected by them. If a large number of them infest a tree, no matter how vigorous it may be, its growth is stopped; no new leaves will appear, and the leaves then upon it will curl up and exhibit a diseased appearance.

Remedies.—When it is discovered that this insect has begun to appear, a close examination of the tree infested by it, followed by a destruction of every individual observed, may save the grower a vast deal of after labor and vexation. A small amount of attention and labor rightly bestowed at this time will be of greater benefit than a large and severe amount of labor would be when they have become fully established. For this purpose a stiff, dry brush may be used to brush the insects off in such a manner as will destroy their lives. They are rather tender, and may readily be killed by the bristles of a stiff brush.

A beetle, *Scolytus Pyri*, infests the twigs of the Pear and some other fruit trees, causing them to die in the middle of summer. It is an elongated cylindrical form, about one-tenth of an inch long, deep brown, with the legs and antennæ of a paler color. The thorax, or that portion of the chest situated immediately behind the head, and to the under side of which the legs are attached, is "short, very convex and rough in front. The cases which

cover the wings are punctured minutely in rows, and slope off very suddenly and obliquely behind. The shanks are widened and flattened at the end, beset with a few small teeth on the outer edge, and terminate in a short hook. The larva (maggot stage of existence) eats its way inward through the alburnum, or sap-wood, into the hardest part of the wood, beginning at the root of a bud behind which the egg was placed, following the course of the eye of the bud towards the pith, around which it passes, and part of which it also consumes: in this manner forming, after penetrating through the alburnum, a circular burrow or passage in the heart-wood contiguous to the pith which it surrounds. By this means the interior of vessels, or those which convey the ascending sap, are divided, and the circulation is cut off. This takes place when the increasing heat of the atmosphere, producing a greater transpiration from the leaves, renders a large and continual flow of sap necessary to supply the evaporation. From this deficiency, or some other unknown cause, the whole of the limb above the seat of the insect's operations suddenly withers and perishes during the intense heat of midsummer." At the bottom of its burrow it undergoes its transformations, and comes forth from thence a perfect winged insect about the last of June or first of July, and probably fecundates and deposits its eggs before the end of August. Professor Peck, who was the first to place on record a history of its economy in the Fourth Volume of the "Massachusetts Agricultural Repository and Journal," has given a figure and very exact account of it. Dr. Harris, in his work upon the Injurious Insects of Massachusetts, has included the observations of Professor Peck, and added many interesting particulars concerning it. He thinks it will be necessary to examine the pear trees daily during the month of June, and watch for the "first indication of the disease, lest the remedy should be applied too late to prevent the spreading of the insects among other trees." Dr. Fitch states that it bores also into the trunk of the tree, and affects other fruit trees in the same manner.

Remedies.—The one suggested by Professor Peck is, in order to prevent other limbs and trees from becoming attacked in the same way, to cut off the blasted limb *below* from the seat of injury, and burn it before the insect makes its escape. It is probable that no means could be applied on a sufficiently large and precise scale to effect the absolute eradication of these insects after a great number of trees have become infested, and hence the means of controlling this serious mischief must be found in methods of prevention rather than in attempted cure. Their mode of penetrating the trunk and the small size of the holes, together with the branching direction of these burrows, precludes the possibility of attacking them at this time with any hope of success.

In the months of June and July the larva of *Celandria Cerasi* will be found consuming the parenchyma of the leaves, but the veins are left entire. It is a snail-resembling, black, slimy slug, of a palish color beneath, and shaped somewhat like a tadpole, the anterior portion being plump, and tapering rather gradually posteriorly. Several of these filthy-looking creatures may frequently be seen on one leaf, and where they are numerous will often entirely destroy a tree by defoliating it, or rendering the leaves unfit for respiration. Like many other insects, they appear to be casual and sometimes local, and in the larva stage alone do they cause extensive or important injury. (See Harris, Ins., &c., p. 383, and Fitch, N. Y. Trans., 1856, 384.)

Remedies.—Dr. Harris states that ashes or quicklime, sifted upon the leaves through a sieve, will be found effectual in destroying the slugs.

Areoda lanigera, a thick, oval, yellow beetle, with a green and golden reflection upon its polished surface, with the under side clothed with white hair, about nine-tenths of an inch in length, is sometimes found eating the leaves in May and June. This insect is local, and probably will not be found south of the lower borders of Pennsylvania. As it has not yet been said to inflict very extensive injury upon this tree, and as it is more frequently met with upon other trees, it may be more properly considered under the head of some other. (See Harris, Ins., &c., p. 22, Fitch, N. Y. Trans., &c., 1856, 354.)

Lytta Pyrivora, probably the same with *L. fulgifer*, Leconte, is said by Dr. Fitch to occur upon the leaves of the pear trees in the West. He states that early in June the perfect beetle devours the young fruit. It is about nine-tenths of an inch in length, of a green-blue color, not shining, with the legs orange-yellow, excepting the hips, knees, tips of the shanks and feet, which are blue-black, the antennæ are black. From an experiment instituted by Dr. Fitch this species, as is also the case with a number of our species of this family, possesses active, vesicating properties. As no insects of this tribe have been found doing extensive damage upon fruit trees in this country, no remedies particularly applicable to them have been suggested.

Some minute species of moths and wasps, yellow-jackets, and hornets will sometimes be found feeding upon the fruit, but except the former none of them are likely to effect much mischief upon this tree.

Carpocapsa Pomonella, commonly called the Codling Moth, is found "feeding upon the core and seeds of the pear, causing much of the fruit to wither and fall." It is in the larva

stage "a small white worm with a shining black head and neck, and with little smooth dots arranged in pairs, each giving forth a fine hair. When they become larger they are flesh-colored, with a tawny head and neck." When fully grown it is somewhat beyond a third of an inch in length, and in summer generally completing its growth in three or four weeks, when it gnaws a hole in the fruit and comes out. It then constructs a web of white silky threads, usually in seams or beneath the loose bark, and after remaining a few days in this state it comes forth a winged moth. The moth expands about three-quarters of an inch from tip to tip of the wings. The fore wings are beautifully marked with numerous transverse gray and brown irregular wavy bands or stripes, and on the inner hind angle is a large oval dark-brown spot, the edges of which are bordered with a brilliant copper color. The hind wings are light-yellowish brown with a lustre, like satin. The head and chest, or thorax, are brown mingled with gray; the abdomen is a light-yellowish brown. This insect has long been found to be a serious nuisance to the grower of *Pomes;* it does not confine itself to the pear, but gratifies itself equally with the fruit of the apple. It is the chief cause of that dust which we so often find in apples and pears situated in the core and about the seeds.

Remedies.—Where trees are suspected to be infested with these insects, a slight shaking of them will cause the fruit to drop. Gusts of wind also, very frequently exhibit the extent of mischief which is going on, by causing all infected fruit to drop. Every pear thus infested should be cleared of the intruder, who should be thrown into the fire or otherwise destroyed. As these insects are found in fruit during nearly all periods of the year, the only way to reduce their numbers will be by attacking them in this larval stage; the moths are too active to be caught extensively, and they generally fly at night. See Kollar, "Insects Injurious to Gardeners, Foresters, and Farmers," p. 229. Also, Harris, Ins., &c., p. 351, &c.; and Dr. Fitch, Report N. Y. Trans., &c., 1856, 347.

APPLE.

The Apple tree is, perhaps, oftener subjected to the injurious depredations of insects than any other fruit which is commonly cultivated amongst us. Every part, from the extremity of the crown to the roots, is particularly open to their attacks.

Commencing with the root, we find an insect which has been frequently noticed in the agricultural publications of some parts of the country, but the little knowledge which had been obtained respecting it did not, until recently, allow a decided opinion to be formed as to its peculiar characteristics and means of injury. Its history is now well enough known to enable any practiced eye to detect its presence and to apply such remedies as may suggest themselves to check or prevent the destruction it can occasion. Dr. Fitch, who was the first to mark it with a name, *(Pemphigus Pyri,)* has given in the New York Trans. Agricultural Society, 1854, p. 709, a very full account of its appearance and habits. The writer has frequently heard of the wooly-winged insects being found in great numbers in some sections of the West, but as yet no individuals of this kind have occurred to him near Baltimore. It is not to be expected, however, that any part of the country will be entirely free from their ravages, and hence it seems still more necessary for the fruit-grower to prevent their spreading by resorting to any means which may be effectual against them. They are by no means confined to the apple, and therefore may appear in any section of the land, even where their presence is least expected. In the young larva state they are of an oval form, slightly more robust than some of the plant-lice, and of a pale, dull yellow color. The legs short and thick, the hind ones but little longer than the others. The antennæ, one projecting from each side of the head, are stout, rounded like a cylinder, but tapering towards their tips, and each about the length of the fore legs. From the tip of the abdomen is projected a white cottony secretion, which is curled and contorted in some individuals, its white color enabling it to be more readily seen by the eye. Its length is scarcely four-hundredths of an inch.

The adult winged insect measures about one-fourth of an inch to the tip of the wings, is of a black color upon the body, legs, and antennæ, these latter organs being about half the length of the body. A dense mass of white or bluish-white, cottony down covers the head and upper surface of the abdomen. "The upper wings are transparent and slightly smoky, as though fine dust had settled upon them. The veins are black, faintly margined with dusky brown. The lower wings are more clear," though not perfectly transparent, and they are not clouded with a smoky shade as in the first ones.

By means of their sharp beaks they puncture the roots and suck the sap. The insertion of their beaks into the bark also causes an increased development of the wood in the shape of warty-like excrescences, sometimes of considerable size, and frequently surrounding the root, produced by the diversion of the sap from its proper channels towards the part in

which this irritation occurs. The eggs are doubtless placed there before the end of autumn, and hatch during the warm weather of the following spring. As is often the case with this family of insects, they probably continue to multiply without copulation, until the protracted life-inspiring influences of the warm weather have developed winged individuals, which fly forth, and, by placing the impregnated eggs in situations proper for their development, secure the brood for the next season. Others, however, are overtaken by the cold weather before the end of their full periodic term of development, and they remain in places of security while the severe weather lasts, to begin the remainder of their active life when the weather becomes warmer.

Remedies.—"When a tree ceases to grow with its usual vigor, and its leaves are of a paler and more yellow hue than usual, and no borers in the trunk, or other obvious cause of disease can be discovered, the presence of this blight upon its roots may be suspected, and the earth should be removed from them sufficiently to ascertain whether excrescences, such as have been described, are formed upon them. If discovered, it will be well to clear away the earth from around them" as much as possible, and pour on strong soap-suds copiously, so as to saturate the crevices, and, indeed, a large stiff paint brush might be very efficiently used to apply the solution upon the inferior surfaces of the roots, &c. "It is chiefly in nurseries, upon the roots of young trees taken up to be transplanted, that the blight will be detected." The roots of all such trees should be dipped in soap-suds, and if the suds alone is not sufficient to destroy them at once, a little agitation of the roots, sufficient to wash them off, will certainly rid you of a serious pest. Ashes may be freely mingled with the soil covering the roots. "Mr. Downing recommends the mixing of a shovelful of ashes with the soil in which such trees are set, which may be as effectual as an immersion of the roots in soap-suds. See also Downing's Horticulturist, vol. iii, p. 394.

Apple-tree Borer, (*Saperda Bivittata*, Say.)—"This is one of the worst enemies against which our apple trees have to contend. It is much more common everywhere in our own country than is generally supposed." As it is an insect whose original food was probably the varietes of thorn, the mountain ash, or the shad bush, its range may be expected to extend as far as these trees will be found to exist and flourish. In some parts of Maryland hundreds of these insects may be collected in a single day by beating the hedges of thorn, *(Crataegus cordata,)* &c. The people in some sections of country insist that certain districts and places are not adapted to, or will not grow the apple. Many persons, also, blame the seasons for the premature death of their apple orchards, where, if they had the proper knowledge or the necessary amount of activity, they might easily discover the seat of the difficulty and apply the remedy, which would finally deliver them from this evil. At this time there is a particular section of country in the State of Virginia where the residents express their entire inability to raise this fruit. They blame the late frosts, and some of them lay the charge upon the extreme cold weather; but in regions of a similar character in New York, and other States where the winters and springs are intensely more severe, large quantities of apples are raised, and many of them of fine quality.

The perfect insect is of an umber-brown color, and has two chalk-white stripes upon the upper surface; one behind each antenna, extending to the tips of the wing-cases. The head is white, excepting a patch at its base and one behind each eye, where it is of an umber-brown; upon the middle of the face it has a small, round or triangular spot, which is intersected by a very fine line extending from the mouth, upwards and backwards, to the hind edge of the thorax. The antennæ and legs are not of so clear a white as the head and breast, owing to the ground color being black, and the white hairs not being so densely compacted together. The eyes are black, and the under surface of the body white. It measures from one-half to more than three-fourths of an inch in length, and from rather less to a little more than a quarter of an inch in breadth.

In the worm stage the most fully developed individuals vary in size. "They are most commonly rather less than an inch long, and over a quarter of an inch in diameter anteriorly at the broadest part. They are of a cylindrical form; the second segment being bulged, and rather broader than the others; the color is a very pale yellow or white, and the consistence of their bodies is soft and fleshy. The head is chestnut brown, polished and horny, with scattered hairs; the upper jaws (mandibles) are deep black, sloped at their tips, which are obtusely rounded; between them appears the labrum or upper lip, of a tawny color, and densely clothed with short hairs; the throat is also pale tawny yellow. The feelers (palpi) consist of a conical, three-jointed process on the under side of each mandible, and inserted upon the lower jaw, (maxilla,) the tip of which slightly projects in the form of a short, roundish process at the inner base of the feelers. The feelers of the lower lip (labial palpi) are also perceptible, forming a conical two-jointed process, of a chestnut color, inside of each lower jaw. The antennæ are represented by a small jointed projecting point near the outer angle of the head, which is exceedingly minute." Upon the surface numerous brown hairs are scattered. "The second segment of the body is larger than any of the others, and its

upper surface slopes downwards and forwards, and is occupied by a large smooth spot of a pale tawny color, the posterior part of which is covered with brown points. Beneath is a smaller transverse spot occupied by similar points, but with a band destitute of them running across the middle, and on each side is a pale, tawny-yellow spot, also destitute of them. The third and fourth segments are shorter than the following ones. On the top of the fourth and each of the succeeding segments to the tenth is a transverse wart-like elevation divided into two parts by a strongly impressed longitudinal line. Along the sides the breathing pores form a row of nine brown dots upon the second, fifth, and each of the following segments, and immediately below these is an elevated longitudinal ridge, which is interrupted at the joints. Beneath, upon the middle of each segment, is a corresponding wart-like prominence upon the fourth to the tenth segment. These segments are thirteen in number. The last one is double, or appears like two segments; its posterior portion being but half as broad as the anterior, into which it is deeply sunk.

The larva state is said to extend through two or three years. The female deposits her eggs in June and July upon the bark at or near the surface of the ground, or occasionally higher up or in the axils of the lower limbs. From these a small, white, footless grub, with a yellowish head, is hatched, which commences eating its way into the bark until it reaches the sap-wood; it then eats gradually upwards, making a path just the size of its body into the sap-wood and bark. When about half grown it commences gnawing through the solid wood, continuing to enlarge the diameter of the burrow as its body increases in size, and pushing the saw-dust so made downwards and outwards towards the orifice, it carries the burrow curvedly backwards until it arrives at the bark. It does not now continue to mine into the bark; but filling up the burrow at each end, and enlarging the cavity, it makes for itself a place to undergo its last transformations, and then quietly awaits its change. When fully completed, it pushes back the castings forming its nest, gnaws a smooth, round hole through the bark, and comes forth. It then continues upon the tree, remaining sluggish and inactive during the day, and prepares to propagate its species.

REMEDIES.—The maggot or grub produces a discoloration as it eats its way through the bark. "If the outer, dark-colored surface be scraped away with a knife during the last of August or forepart of September, so as to expose the clean white bark beneath, as can be done without injury to the tree, the young worm will be readily detected," and may at once be destroyed. It will be discovered by the appearance of a blackish spot, rather larger than a grain of wheat, and may be cut out with a knife.

But when the trees have been neglected, the worms will be found in their burrows, and must there be attacked singly. This may seem like an endless work, where large numbers of trees have to be gone over, but it is better to take this great pains than to lose an extensive and valuable orchard. Their presence can now be readily ascertained by looking attentively for the litle holes through the bark, out of which fine sawdust-like castings will be discovered to proceed. Dr. Fitch suggests that the upper end of the burrow may be found by probing with a fine awl above the orifice where the castings are projected, perhaps at a distance of three inches; when the burrow is pierced it will be known by the easy, deep penetration of the awl, and then an excavation can be made through the bark, into which hot water may be poured, which will destroy the worm. The most efficient way of avoiding these difficulties, however, is to prevent the beetle from depositing her eggs. This may easily be done by rubbing the bark of the trunk and around the lower limbs with soft-soap, or some other alkaline preparation, during the latter part of May. For a very full and complete history of this insect, and the remedies to be employed against it, see Dr. Fitch, Trans. N. Y. Agricult. Soc., 1854, p. 715, and 1856, p. 321.

APPLE BUPRESTIS, (*Chrysobothris femorata*, Fab.)—Another borer, of an entirely different form and appearance in the perfect stage, has been found to commit very serious mischief in some sections of the country. The beetle is from one-third to one-half of an inch in length. It is oblong, rather flattened above, where it is of a brassy blackish color, sometimes a little brighter upon the head and thorax, and upon the latter it has a very shallow longitudinal impression each side. The whole upper surface appears roughened like shagreen, and upon each wing-cover there are two irregular, shallow impressions: the one placed before the middle, the other just behind it; the latter impression being much the largest; and both of them serve to interrupt three fine, elevated, longitudinal lines. Beneath, the color is a brilliant copper, polished upon the edges of the abdominal segments. The antennæ are about equal to the thorax in length, and after the third joint they appear exteriorly to be finely toothed like a saw. Each of the thick front thighs is armed with a short stout tooth; the hinder ones are not quite so robust, and all the legs appear rather short.

The larva is a whitish yellow, footless grub, round and flattened, with its anterior end enormously broadened, and having a pair of stout, short jaws of a black color. The perfect insect deposits its eggs upon the bark, from which a worm hatches, and bores its way through the bark. During the first periods of its young life it bores a broad, shallow exca-

vation, just large enough for its passage, along the soft sap-wood immediately beneath the bark. When, however, the worm has increased in size and strength, it bores into the more solid heart wood, excavating a burrow twice as wide as it is deep. It is in the later part of the summer when these larvæ sink themselves into the hard wood, and they evidently do this as a provision for security during the cold of winter, when they become torpid. These worms are subject to the attacks of a parasite, which eats out all the soft parts, and leaves only the skin untouched: its history, however, is not complete enough to allow of any probable conjectures respecting the amount of service which it may occasion.

REMEDIES.—"The remedies for destroying this borer must necessarily be much the same as those already stated for the common borer or striped *Saperda*. They consist essentially of three measures: 1st, coating or impregnating the bark with some substance repulsive to the insect; 2d, destroying the beetle by picking it from the bark with the hands and crushing it; and 3d, destroying the larva by cutting into and extracting it from its burrow." The former may be done by whitewashing the trunk and large limbs, or rubbing them over with soft-soap, during the early part of June. The latter method may be adopted when the insect is young, before it has penetrated into the solid wood, by noticing the holes from which their castings are thrown out. It may be discovered by probing with a fine awl, and then the burrow must be cut open and the insect will appear, probably at its upper end. This operation should be performed in August or September; and in young trees, where the bark is thin and tender, it will be easy to ascertain where the hollow cavity lies, and it may then be traced to where the culprit is located.

APPLE-BARK LOUSE, (*Aspidiotus conchiformis*, Gmelin.)—This pernicious insect belongs to the same family as the three others before noticed, as doing injury to the pear tree. It is a narrow, oblong, slightly-curved, muscle-shaped scale, of a brown color, about one-eighth of an inch long, and somewhat resembling a slightly-raised blister. "When first hatched from the egg the larva is but about half the size of the egg, of an oval form, and a pale dull yellow color. Three pairs of legs are perceptible, two placed anteriorly, the others posteriorly and distant. It walks about with much life and agility." Dr. Fitch has found individual larvæ hatched as early as the 12th of May, and they ran about actively among the eggs, but did not leave the maternal scale. In about two weeks longer the young crawl out from beneath the scale and scatter themselves over the bark.

REMEDIES.—Many remedies have been spoken of in various agricultural periodicals, and a secret remedy, which was hawked about in parts of the West, (an infusion of quassia,) was found upon trial to be ineffectual. Lye, potash water, whitewash, dry ashes, and sulphur are among the agents which have been recommended to check their ravages. "A writer in the Michigan Farmer (vol. 13, p. 82) gives a favorable account of the effects of tar and linseed oil beat together, and applied warm with a brush thoroughly before the buds expand in the spring. This, when dry, peels off, bringing the dead scales with it. The remedy to which Esquire Kimball, of Kenosha, Wisconsin, resorts is probably one of the most efficacious, and as convenient as any. He boils leaf tobacco in strong lye till it is reduced to an impalpable pulp, and mixes with it cold-made soft-soap till the mass is about the consistence of thin paint, the object being to obtain a preparation that will not be entirely washed from the tree by the first rains that occur, as lye, tobacco water, &c. The fibres of tobacco diffused through the preparation cause a portion of its strength to remain wherever it is applied longer than any application which is wholly soluble in rain water can do." For a more full account of this species see Dr. Fitch, Trans. N. Y. Agricult. Society, 1854, p. 732.

PRICKLY LEPTOSTYLUS, (*Leptostylus aculiferus*, Say.)—This is a little, stout, long-horned beetle, about one-third of an inch in length, of an ash-gray color; the wing-covers behind the middle crossed by a broad white band, at the hind border of which a black streak or spot is conspicuous. The thighs are very stout towards their tips, and the shanks, which are of a more uniform thickness, have a black band each side of the middle. The thorax has an interrupted elevated line on the middle, and two or three elevated lines or prominences each side of the middle. The whole upper surface of the wing-covers appears studded with small elevated points like prickles, and the antennæ are encircled by numerous narrow black rings. The thorax appears much narrower than the wing-covers, and the wing-covers are strongly convex above, and appear obliquely cut off at their tips.

The larvæ burrow out long, shallow, winding cavities in the wood just beneath the bark, increasing in breadth as the worm increases in size, but never found buried in the heart wood or deeply excavated, as with the *Buprestis*. These larvæ resemble those of the "apple-tree borer," but never attain so large a size. The beetle issues from the trees in the month of September, and in this month the eggs are laid. "They usually emerge from the trunk near the main branches on the south side of the tree, and as frequently as otherwise from the forks of the main branches. Its burrows, however, made during the worm state are found in all parts of the stem." Much damage has been caused by these borers in particular portions of the Northwest; but it is difficult to decide whether it has not destroyed many

trees growing in an Atlantic region. It is certainly common in many parts of the Middle States, and, as its natural food appears to be the sycamore, it may be expected to be widely diffused.

REMEDIES.—These are, as yet, only conjectural; the alkaline preparations which are recommended to be used for washing the bark of apple trees in May and June to repel the "common borer" and the *Buprestis* will be of no avail against this insect, unless those operations are performed during the latter part of August. Where the tree is known or conjectured to be infested with this borer the holes may be looked for, and the cavity where the worm lies being found by probing, he must be cut out and destroyed. For a particular and interesting account of this insect see Country Gentleman, vol. ix, p. 78, 1857.

THE APPLE-BARK BEETLE, (*Tomicus Mali*, Fitch.)—The beetle is of an elongated, cylindrical form, smooth, slender, black, and sometimes dark chestnut red. The legs and antennæ are pale yellowish-white or dull yellowish. The thorax is finely punctured in front. The wing-covers (as is usual with these species) are obliquely cut off at the ends in this species less abrupt than usual, "with an excavation or groove along the suture, which gives the apex a notched appearance; and near the middle of the declivity, on each side of this groove, is a slightly elevated tubercle of the shape of a crescent, with its concave side towards the suture." It measures about one-tenth of an inch in length. It makes its appearance in young, vigorous trees soon after putting forth their leaves in spring, causing the leaves to wither as though scorched by fire; the bark becomes loose from the wood, and shortly after numerous pin-holes will be seen penetrating through the bark and into the wood, from which the beetle emerges. The history of this insect has not yet been fully recorded, and it remains too incomplete to allow of any ascertainment respecting the efficiency of means which might be employed to combat it. Probably the preventive measures, such as painting the bark with some of the before-mentioned decoctions or washes, which may be done in the spring, before the usual time of appearance of the insect, will be found effective.

Scolytus Pyri, Peck, is said to injure the bark of the apple tree, but as this insect has been noticed, when speaking of the species infesting the pear, any further notice of it in this place will be unnecessary.

An immense number of insects find a habitation in, and subsist upon the decaying trunk of, the tree whilst still standing, and many others feed upon the various *cryptogamia* growths which arise in the tree after it has fallen and becomes the receptacle of the moisture of the earth and atmosphere. With these classes we have only to do with such as contribute to the decay of the tree whilst living. Among these are—

THE HORN BUG, (*Lucanus capreolus*, Linn.)—This is a very large, smooth, dark-brown beetle, measuring from one to one and one-quarter inch in length. Upon the head, in the male, two long, sickle-shaped pincers, armed with a small tooth inside, are placed; those in the female are much more robust and shorter. This species has various provincial names applied to it, but it is, perhaps, best known under the name above applied, and which is the only reason for our adopting it in this place. The larva is a large, thick, almost cylindrical white worm, with the posterior portion of the body curved downwards and forwards. The head and legs, which are six in number, are tawny reddish, the mouth darker. The larva may do considerable damage in old or hollow apple trees by burrowing into the wood of the trunk and roots. The time of its appearance is in July and August.

THE ROUGH OSMODERMA, (*Osmoderma scabra*, Beauv.) in the larva state, is similar in size and shape to the preceding, but much more rough and wrinkled transversely. The beetle is broad, oval, coarsely punctured, and flat upon the wing-covers, which are covered with fine elevated, dense granulations, and with impressed longitudinal lines on the middle. The color is of a rich, brownish black, sometimes with a brassy tinge. The edge of the head is turned up. The beetle measures three-fourths of an inch to an inch and one-tenth in length. The larvæ live in the hollows of diseased apple and other trees, and hasten their death by feeding upon the infected wood, and causing it to decay more rapidly. In the autumn each larva constructs for himself an oval cell, or pod, of fragments of the wood, strongly cemented with a kind of glue; in this case it undergoes the final transformation, and comes forth a perfect beetle in the month of July.

THE SMOOTH OSMODERMA (*Osmoderma eremicola*, Knoch.) is very similar in its habits to the preceding, but differs much from it in appearance when in the perfect stage. The beetle is of nearly the same form, deep mahogany brown, sometimes with a greenish reflection and perfectly smooth and shining. The males have a broad transverse depression upon the forepart of the thorax. It is generally a little larger and more robust posteriorly than the foregoing species, and, like it, delights in luxuriating upon the juices of the apple and some other trees. The odor, resembling that of Russia leather, emitted by these two species is so powerful as to be appreciated sometimes at the distance of fifteen or twenty feet from the insect. For further particulars respecting these species see Harris, Injurious Ins., Mass.; Dr. Fitch, Trans. N. Y. Agricult. Soc., 1856, 329.

The Big-eyed Snapping Beetle, (*Alaus Oculatus*, Linn.)—This is one of the largest insects belonging to its family, and is very remarkable and attractive from the singularity and distinctness of its markings. The perfect beetle measures from one and a quarter to one inch and three-quarters in length. "It is of a black color; the thorax is oblong-square, and nearly one-third the length of the whole body, covered above with a white powder, and with a large oval velvet-like black spot, resembling an eye, on each side of the middle. The wing-covers are marked with slender longitudinal impressed lines, and are sprinkled with numerous white dots; the under side of the body and the legs are covered with a white mealy powder." It is sometimes found quite common about the roots of old oak trees, on fences, &c. They are also sometimes numerous in old apple trees, upon the wood of which the larva feeds. These larvæ are reddish-yellow grubs, proportionally much broader than the other kinds, very much flattened, and are dusky or blackish at each end. They grow to two and a half inches in length, by four-tenths of an inch in breadth, and appear rather broadest in the middle. The last segment has two thorn-like points curving upwards, and on its under side a soft retractile pro-leg, with six small slender legs anteriorly. The time of its appearance in the perfect state is during the months of June and July. As no very extensive damage is reported to have been caused by the few last-mentioned insects, no extended observations and experiments have been made to attempt to exterminate them; but as the holes perforated by the larvæ become very large, it would seem comparatively easy to destroy them while burrowing into the hard wood, by observing the places where they are located and cutting them out.—(See Dr. Harris, Inj. Ins., Mass., p. 48. Fitch, Trans. N. Y. Agricult. Soc., 1856, 329.)

Apple-twig Borer, (*Bostrichus Cicandatus*, Say.)—This pernicious insect has, fortunately, not yet appeared in such considerable numbers as to cause very extensive damage; but, should it once become established, and spread itself in any section of the country, it is hardly possible to estimate the damage which it might occasion. "Particular twigs wither and their leaves turn brown in midsummer, with a hole, the size of a knitting needle, perforated at one of the buds, some six or twelve inches below the tip end of the twig, this hole running into the heart of the twig, which is consumed some inches in length. The beetle is a small cylindrical insect, of a dark chestnut-brown, black beneath, the forepart of its thorax rough from minute elevated points. The male is furnished with two little horns, and the tips of the wing-covers above are armed with two prickle-like points which curve inwards. They measure from one-fourth to rather more than one-third of an inch in length."

Remedies.—The best plan which can probably be adopted to exterminate these insects will be to saw off every infested limb beyond the point where the larvæ penetrate and burn it in the fire. Some of the mixtures before noticed may prove efficient in deterring the insect from alighting and depositing its eggs in the tree. Some of the insects of this genus damage the trees only in their perfect stage. This is probably the case here. Hence we may conclude with tolerable certainty that one of the present methods will be the best that can be adopted.

New York Weevil, (*Ithycerus Nova Eboracensis*, Forster.)—It eats the bud and gnaws into the twigs at their base, often cutting it to the pith. It is a gray insect, with a broad snout projecting downwards, with two elbowed antennæ attached near the middle, and having each of its wing-covers ornamented with four white lines, interrupted by black dots. The thorax has three whitish lines and the under side of a pale gray. It measures from one-third to six-tenths of an inch in length.

Remedies.—As this beetle appears in May and June, it may be almost entirely cleared out by placing sheets beneath the infested trees and giving them a good shaking. This must be done early in the morning, and by persisting in it for a few days after the beetles have begun to appear, their numbers will steadily decrease. The insects will be found lying, feigning death, upon the sheets, and they should be gathered and destroyed; the most effectually by burning them.

The American Lackey Moth, (*Clisiocampa Americana*, Harris.)—This insect is, perhaps, more widely known than any other, which appropriates to itself the leaves of the apple. It is one of the very common caterpillars, which constructs a web for itself upon the trees. But, although this caterpillar has been so often seen by persons in most parts of the country, scarcely any have known the moth which proceeds from it, or recognized it as the species from the eggs of which these caterpillars are hatched. The moth places her eggs in clusters near the ends of the twigs, forming a ring or rather thick belt, surrounding the branch entirely or in part, and they are placed perpendicularly upon the twig, to which they are firmly glued. They are of a short, cylindrical form, with abruptly rounded ends. The shell is composed of a very tough, leathery integument of an ash-gray or white color, the inside having a bluish tinge somewhat resembling that of mother-of-pearl. They are also arranged side by side, somewhat symmetrically, in rows, their sides being slightly indented

or moulded to each other, and all firmly glued together in one mass. These eggs are deposited upon the twigs during the forepart of July, and remain through the autumn and winter and until the latter part of April and the beginning of May, when the young caterpillars hatch from them. The infantile caterpillars, having subsisted for a short time upon the matter which envelops the eggs until they have attained sufficient strength for the journey, move down the limb one after another, each spinning from its mouth a fine silken thread which it attaches to the bark, and which serves to furnish it with a more secure foothold, as well as to those which follow after. On coming to a fork of the limb they halt, and there erect a kind of tent for their subsequent residence by travelling around the spot, spinning their threads in every direction, and thereby forming a web similar to one constructed by some spiders. This is at first quite slight, and not wholly adequate to shelter them; and if a rain comes on it penetrates the web everywhere, causing the young worms to crowd together in its driest part upon the under side of the limb. But thousands of additional threads being furnished to it every fair day, it rapidly becomes more substantial and better adapted for their protection. These caterpillars hatch earlier or later, accordingly as the season is forward or backward. Commonly the earliest cluster of eggs are hatched by the twenty-fifth of April, and the latest a fortnight or more afterwards. When the worms first emerge from the egg they are less than the tenth of an inch in length, about the thickness of an ordinary pin, their bodies broadest at the head, and gently tapering, of a black color, with pale feet, and slightly clothed with fine whitish hairs. At first they only nibble a small spot upon the surface of the leaf, or perforate a small hole through it, or gnaw a small notch in the edge; but as they increase in size they become more voracious, and leave the tent more frequently to seek for food. They change the skin five or six times at intervals from three to nine days, and after each moult they assume a change of color and appear considerably larger. When fully grown, the caterpillar is about two inches long, somewhat over a quarter of an inch thick, has sixteen feet, and is thinly clothed with fine soft yellowish hair. The body is black, a white stripe extends along its entire length, commencing upon the second or base of the first segment, behind the head. In this stripe are numerous minute black dots, and on each side are a great many short, irregular, longitudinal wavy lines of a yellow color which become paler down upon the sides. Above the lowermost series of these lines is a row of transverse, oval pale-blue spots, one upon the middle of each segment. On the anterior side of each of these spots is a broader, deep velvety black spot, forward of which is a rather faint pale-blue oblong spot, or short stripe, reaching to the front margin of the segment. Lower down the sides are mottled with the same pale-blue coloring, interspersed with short wavy lines of yellow or whitish. The under side of the body and the legs are black, the soles of the pro-legs white. The anterior edge of the segment, just behind the head, is also white, with two small, somewhat square yellow spots above. The cocoons are oval, yellow, constructed of loosely woven hairs, and measure nearly an inch in length. This stage lasts about two weeks, and the winged moth comes forth. In the moth state it is of a dull reddish or fox color, the females being paler, more inclined to gray, and are usually much larger than the males. The fore wings are crossed obliquely by two white lines which run parallel with each other, dividing the wing into three nearly equal areas. Occasionally these stripes approach each other more nearly, and the anterior stripe is broader than the posterior one. The hind wings are of the same color as the others, but they are destitute of bands or marks. On the under side the wings are the same color as above, and commonly the pair of white stripes is extended back and curving upon the hind wings. The shaft of the antennæ is dull white, and its branches are dark rusty red, sometimes with a whitish line upon their outer side. The feet are white or yellowish, particularly in the males. The wings spread from one inch and two-tenths to one inch and three-tenths in the males, and from one inch and four-tenths to two inches in the females. It is subject to much variation in coloring.

Remedies.—Many remedies have been proposed for the extermination of these pests, but most of them have been found to be of little benefit. The means of extermination may be commenced with the egg; the large clusters in which they are placed will enable them to be readily seen, when they may be thrown into some kind of a vessel, in which they can then be carried away and burnt. The caterpillars, when rather young, with their nests, may be swept from the tree and consumed by fire. For a very full and interesting account of this insect and its habits, see Harris, Inj. Ins., Mass, 269; also, Fitch, Trans. N. Y. Agricult. Soc., 1855, p. 413.

WINE-MAKING.

Extracts.—Translated from Dr. Ludwig Gall's "Practical Guide for making very good middling Wines (III *quality) from Unripe Grapes, and an excellent Wine from the pressed skins, or husks; also, valuable Dessert Wines* (I–II *qualities) by previous gathering, selecting and sorting the Grapes; together with accounts of my method of changing inferior products everywhere, and at all seasons, into good middling Wines."*

Dr. Gall's treatise affords an historical account of the labors of his predecessors in the improvement of wine, among whom he quotes numerous French, English, and German writers, as Messrs. Maupin, Lenoir, Delavan, Chaptal, Claudot-Dumont, Payen, Dr. McCulloch, Roberts, Freiherr von Babo, Professor Balling, Dr. Dobereiner, Bartels, Dr. F. X. Hlubeck, Hörter, Leuchs, Baron Von Liebig, and Dr. Ritter. To Cadet de Vaux he attributes the merit of originating a better method of using the pomace, or husks, of the pressed grapes for the manufacture of wine.

Of fruits that grow almost without culture we first carefully pluck off such as are ripe, as in the case of cherries, plums, pears, &c., leaving the others to ripen; but as to the grape, this plant of noble growth, to cultivate which is so laborious and costly, while on its success and proper treatment depends the prosperity of whole communities, the good and bad, ripe and unripe, are plucked off indiscriminately and thrown together in one mass, though there is no species of fruit that varies more as to the time of its ripening.

The variety of soil and kind of grapes, their treatment, position, and aspect where they are grown with the age of the vines, cause an important difference in the time of their coming to maturity.

The grapes on the same vine ripen earlier the nearer they are to the ground, and even in the same cluster we find berries of various degrees of ripeness, especially in inferior and middling years. But notwithstanding the above five reasons which cause an unequal ripening, the whole crop is almost everywhere carried off at one time and put together as though of one quality.

If the vintage takes place at the stage of the first ripening, the unripe grapes are added to the ripe; and if, as is now often the case, there is a waiting for the last to ripen, a great portion in the meantime is lost by their bursting open, rotting, or withering and falling to the ground.

Though the practice has not become general to gather grapes, as in the case of orchard fruit as they ripen, and so, if necessary, two or three times in succession, yet there are not wanting encouraging examples in this respect equally with other advances in the culture of wines, where for more than a quarter of a century some proprietors have carried out these principles of sound sense with extraordinary success.

It thus depends upon ourselves to make better middling wines (table wines) from quite unripe grapes separated from the ripe than heretofore has been produced in middling years from the whole mass of the crop thrown together. As there are some perfectly ripe grapes every year, total failures excepted, it depends on us likewise to manufacture yearly a portion of bouquet and dessert wines, such as can only be produced from perfectly ripe grapes. It has been demonstrated both by science and experience that if the most perfect wine which can be obtained from any vineyard is only produced from all the substances that are combined in the best ripened grapes, nothing is required for making good and even better middling wines than those made in middling years up to the present time, but that the must, to be fermented, should contain (besides some few certain substances present in small though always sufficient quantities, in the unripe as well as the ripe grape) the principal constituent parts for the formation of the wines referred to, sugar-free acids, and water in such proportions as they are found in the must of perfectly ripened grapes of the same variety and best location.

Whether the sun has produced in the grapes themselves all the sugar necessary for the formation of middling wine of this quality, or it is derived from other plants and added to the must in the requisite proportion, is immaterial. The same is the case as to the water, the quantity of which in unripe grapes is too small in proportion to the acids, compared with ripe ones. It should therefore be the object with the thoughtful wine-grower, by gathering at several and suitable periods, to secure the largest possible quantity of ripe grapes for making those valuable wines of the first and second qualities, or the must from

the rest of the grapes, in which the quantities of sugar, acids, and water vary every year: he must add to it, in right proportions, those constituent parts that are wanting, so as to make in the most unfavorable seasons and from the most inferior grapes wines at least of the third quality, or good middling wines for the consumption at large.

METHODS OF GATHERING GRAPES ADOPTED AT JOHANNISBERG BY MR. ACKERMANN, AT NACKENHEIM, ON THE RHINE, AND AT TOKAY AND SIRMIA, IN HUNGARY.

JOHANNISBERG.—In order that the grapes may have time to ripen perfectly, the vintage takes place as late as practicable, usually in November, often after the first fall of snow, and only in the most favorable seasons, as early as in the month of October. The care and attention generally given to the vintage and the treatment of the wine are among the chief means of the production of so excellent an article. The laborers are strictly forbidden to eat any grapes, under the penalty of the loss of future employment, yet during the vintage they are allowed double wages. The thoroughly ripened grapes only are put into the press. The gathering is not completed at once, none but the ripest being picked, and many a vine is entirely stripped at the fourth picking. Dry and fine weather is deemed indispensable to the vintage. For the finest so-called "choice wines" the ripest of the best kinds of grapes, grown in the most favorable situation, are cut off with small scissors, and after lying twenty-four hours pressed separately from the rest. This fact in some measure explains the high prices they bring.

MR. ACKERMANN, AT NACKENHEIM, ON THE RHINE, believing that perfectly ripe grapes contain in just proportions all that is requisite, water included, never begins to gather his grapes whilst they are wet with dew or rain. He lets them remain as long as possible on the vine, gathering, however, those that are perfectly ripe as often as may be necessary, to avoid loss by rotting. He forbids the eating of grapes, either in the press-house or in the vineyard, under penalty of dismissal and loss of wages, but he pays double wages, even though the weather should allow but a few hours' work in a day.

AT TOKAY AND SIRMIA, IN HUNGARY.—The fine, delicious wines known out of Hungary collectively by the name of Tokay are made from the so-called "dry berries," or such as have almost become raisins on the vine. The latter part of summer and fall are the finest and least variable seasons in Hungary, and therefore the grapes are usually ripe at the end of September; but to obtain good choice wine they should be more than ripe. The vintage is therefore delayed, as at Johannisberg, until November, and very often until the first frosts set in, when the ripest berries, by the gradual stoppage of circulation of the sap of the vine, shrink up into raisins, losing their translucency, and assuming a brown color, which, if the weather continues favorable, turns bluish.

As soon as dry berries begin to show themselves the opening vintage begins, and intelligent proprietors gather under careful supervision the best dry fruit from day to day, deferring the main or general vintage as long as possible, in order to obtain a greater quantity of such berries.

At the general vintage shortly following the gatherers form a line, advancing equally, each provided both with a wooden hand-tub, to contain the common grapes, and with a smaller wooden vessel, fastened to the body, to receive the dry berries still picked from the clusters. The gatherers are followed by an overseer, who sees that no grapes are eaten, and who from time to time, through one of the carriers, collects the dry berries already picked and deposits them in one of the vats until wanted for pressing. He also takes care that the gatherers advance in regular order, so that no vine be passed by, and that the berries fallen off are carefully picked up. That no dry berries may be lost, the clusters, before being conveyed to the press-house, are subjected to another examination. For this purpose large tables are placed outside of the vineyard, on which the grapes are spread and searched by children for dry berries, who at the same time remove all the dried, rotten berries. In this second picking during the principal gathering the fresh grapes are gently put into the tubs, since if crushed or bruised by being spread upon the tables great losses would be the result.

A FEW GLANCES AT THE NATURE OF THINGS IN THE MANUFACTURE OF WINE.

To form a correct opinion of what may and can be done in the manufacture of wine we must be thoroughly convinced that Nature, in her operations, has other objects in view than merely to serve man as his careful cook and butler. Had the highest object in the creation of the grape been simply to combine in the juice of the fruit nothing but what is indispensable to the formation of that delicious beverage for the accommodation of man, it might

have been still easier done for him by at once filling the berries with wine already made. But in the production of fruits the first object of all is to provide for the propagation and preservation of the species. Each fruit contains the germ of a new plant, and a quantity of nutritious matter surrounding and enveloping this germ. The general belief is that this nutritious matter, and even the peculiar combination in which it is found in the fruit, has been made directly for the immediate use of man. This, however, is a mistake. The nutritious matter of the grape, that is, the different substances contained in each berry, as in the pea, apple, or any similar product, is designed by Nature only to serve as the first nourishment of the future plant, the germ of which lies in it. There are thousands upon thousands of fruits of no use whatever, and are even noxious, and there are thousands more which, before they can be used, must be divested of certain parts necessary, indeed, to the nutrition of the future plant, but unfit, either directly or indirectly, for the nourishment of man. For instance, barley contains starch, mucilaginous sugar, gum, adhesive matter, vegetable albumen, phosphate of lime, oil, fibre, and water.

All these are necessary to the formation of roots, stalks, leaves, flowers, and the new grain; but for the manufacture of beer the brewer needs only the first three substances, and for brandy or spirits the starch merely is required from this as from any other cereal or potatoes; just as in the manufacture of beet-sugar, of all the seven substances composing the beet-root, the sugar only, contained in the juice of the root, is of use. The same rule applies to the grape. * * * * * * * * *

In his use of the grape all depends upon the judgment of man to select such of its parts as he wishes, and by his skill he adapts and applies them in the best manner to his purposes. In eating grapes he throws away their skins and seeds; for raisins he evaporates the water, retaining only the solid parts, from which, when he uses them, he rejects their seeds. If he manufactures must he lets the skins remain. In making wine he sets free the carbonic acid contained in the must and removes the lees, gum, tartar, and, in short, everything deposited during and immediately after the process of fermentation, as well as when it is put into casks or bottles. He not only removes from the wine its sediments, but watches the fermentation and checks it as soon as its vinous fermentation is over and the formation of vinegar is about to begin. He refines his wine, likewise, by an addition of foreign substances; he sulphurizes it and, by one means or other, remedies its distempers.

The manufacture of wine is thus a many-sided art, and he who does not understand it, or know how to guide and direct the powers of Nature to his own purposes, may as well give up all hope of success in the same.

THE GRAPE IN ITS EXTERNAL AND INTERNAL CONDITION AND CONSTITUENT PARTS.

The attentive vintager who studies the book of Nature may derive the plainest rules for his guidance in the manufacture of wine from his knowledge of the external and internal condition of the grape, and particularly from indications easily observed during the ripening. These are such as are seen in all fruits, and consist simply in the fact that the degree of its sweetness (quantity of sugar) increases with advancing ripeness, while the acid is at the same time diminished. But the practical application of this fact has not yet been fully acknowledged, owing, perhaps, to the circumstances that the acid diminishes in a much smaller proportion than that in which the sweetness is increased, from which it has been concluded that only a portion and not all of the sugar of the grape may have been formed from its acids or other substances. Yet the assertion above made as to the formation of the whole amount of sugar will, in my view, admit of a full explanation.

I look upon each berry as a kind of chemical laboratory, in which in secret a chemist prepares from the vegetable matter, continually gathering within it those substances necessary to the nourishment of the germs of new plants contained in the seeds. After a certain store of acids has been prepared in this laboratory during the green state of the grape, the sun's warmth, increasing as the season advances, begins with the earliest period of ripening of those acids into sugar. An examination of bunches at intervals of eight days, or still better of an equal number of the berries of ten or more different bunches on the same vine as to their proportions of sugar and acid, will show from one to two per cent. more sugar, and hardly one-tenth per cent. less acid than there were eight days before.

It is, however, quite certain that one-tenth per cent. of acid cannot have produced two per cent. of sugar. But while the sun is engaged in the manufacture of sugar from the acids, the secret chemist also continues preparing acids from a portion of the juices which are constantly pouring in, and thus keeps the sun supplied with raw material for the production of sugar. Now, if the sun is more active than the chemist, or if, towards the close of the ripening of the grapes, when the leaves begin to wither, the supply of juice be diminished,

he will use more acids than the chemist can furnish. For instance, if the sun produces one per cent. of sugar in eight days, while the chemist makes but 0.8 per cent. of acids, the store of the latter, or the quantity of acids in the juice, is reduced 0.2 per cent.

We can thus explain how sugar may be formed from the acids of the grape in a much larger proportion than that in which the acids are diminished. This being the case, it is important that, if practicable, the grapes should only be gathered in a perfectly ripe state, as the changes essential to the production of the choicer wines occur during the last days of ripening.

As to the formation of the bunch it consists of a great number of berrries, every one by its roundness presenting a large surface in proportion to its bulk, by which means it can retain considerable water after being wet by either dew or rain. In most varieties the berries are so thickly set as to form a thick wall around the inner cavity. Within this cavity, and in the spaces between the berries, a still larger quantity of water is retained. Thus, if the grapes are harvested during humid or rainy weather, a considerable amount of atmospheric water necessarily enters into the must, and that this has an influence on the wine produced is easily seen. Here, however, we only call the attention to the fact, intending hereafter to show its importance, and to point out the mode of preventing any injury, and securing the advantages that may thus be realized.

As to the character of the grape internally, if the skin is cut across by a sharp penknife, the contents appear at first sight as a homogeneous marrow or pulp surrounding the seeds. On a closer examination fibres are observed crossing each other in different directions ; and these are the divided walls of numberless small cells. In unripe grapes the whole matter contained in these cells consists of various citric and grape acids, tartar, traces of a few other salts, adhesive substance or bodies of Protein (from which the lees needed for exciting fermentation are formed) and water. During the process of ripening, grape-sugar is produced from the elements of the fibrous substance, part of the acids, and water. This change first takes place on the surface of the berries beneath the skin, and gradually, though continually slower, extends to the centre as the ripening is effected by the heat of the sun. Thus is explained why the juice from just beneath the skin of berries not perfectly ripe appears sweet, while the mass of the pulp around the seeds is more or less acid according to the degree of ripeness.

The correctness of this assertion can readily be ascertained by taking a ripe and perfect berry between the ends of the thumb, the first and middle fingers, and giving it an equal pressure from all sides. The central marrow or the acid mass of the interior enclosing the seeds, and held together by the still unchanged cellular texture, is forced out almost uninjured, and only the thin and fluid marrow which surrounds the inner mass is dissolved into a sweet juice. If the central marrow of some twenty berries is thus forced out, and collected in a small linen bag, juice will flow from it under a strong pressure. In this juice an acid and an acrid taste more or less predominates according to the degree of ripeness, and the drops last pressed out contain but little sweetness. Even the skins put into a bag will, under a great pressure, yield some juice, though of a more acid character than in the former case. The inner structure of the berry, therefore, teaches the method of obtaining that juice, which is purer and best adapted to the manufacture of good wine, and of separating it from the other of a more acid or bitter taste. These remarks are likewise applicable to the process of pressing on a larger scale.

I know that it is contended, and I am far from disputing it, that wines containing no acids and bitter stuffs have not a good flavor, and will not keep ; yet there must be certain proportions in all things, and the question is whether the necessary quantity of acidity and bitter substance does not exist in the juice of perfectly ripe grapes? These contain either everything, and in the right proportions requisite for perfect wine, or acids and bitter substances should be added to the must of even the best years to produce wine that will keep—an opinion which no one will admit. What wine-producer does not know the fabulous prices paid for choice wines, or wines the grapes for which were carefully selected before the rest had attained their ripeness?

Thus, for the cabinet wine of Johannisberg, pressed from the selected and ripest berries, eleven guilders a bottle has been paid ; and in 1832, by a careful choice of the berries, a wine was produced in the Palatinate which sold for 4,000 to 8,000 florins per cask.

I admit, indeed, that as long as it was not known that the value of the wines, at least of the middle wines, mainly depends on a certain medium quantity of acid, a rule was wanting for mixing the musts obtained from different pressings; and I admit also that, according to the former belief, the acid juice of the last pressing could not be rendered valuable except by mixture with good must; but the investigations on this subject by Dr. Lüdersdorf should now at the present day be known to every owner of vineyards who lays a claim to education.

Viewing all this as do those who believe the grape created by Nature only for wine, must

we not admire that provident Wisdom which, while she continues the cellular tissue in its more or less unripe interior of the berry, seems desirous to retain the acid mucus that is less adapted to the production of the wine. Does she not thus rebuke the great efforts made by some to mix anew the bad juice, which she in her wisdom withheld, with the good she so willingly yields?

Of water.—Water forms, in bulk and weight, the principal constituent of wine, as of all other kinds of beverage. Upon its proportion in the composition mainly depends not only the process and perfection of fermentation, but also the quality of the product.

The water naturally present in the must contains the other constituents in solution, just as sugar-water contains the sugar. By distilling must we may obtain pure and tasteless water. Neither the water of rivers, springs, and wells, nor any other water naturally existing on and in the earth is as pure as this distilled water. But since the impurities of these waters consist merely in earthy particles, some of which will settle at the bottom, and others combine with a small portion of the acids of the must, and then become so settled, every kind of clear water of pure smell and taste may be employed for diluting such must as contains too much acid. The use of stagnant or well water in the neighborhood of privies or dung-yards should, of course, be most strictly avoided.

We have already stated how greatly the form of the bunches during a wet vintage contributes to the more or less admixture of rain-water with the must. We now propose to ascertain more accurately the quantity and effect of this water, not only to elicit suggestions, for the vintage itself, but also to furnish new proofs of the propriety of our diluting the surplus acid in the must by the addition of water.

If a bunch of grapes picked on a warm day, and accurately weighed, be put for an hour into a vessel containing water, and then weighed again, it will be found to have increased in weight from eight to twelve per cent., according as the berries are more or less thickly set together. If then the vintage takes place after a rain or a heavy dew, from eight to twelve per cent. of water will be thrown into the vats with the grapes.

As one hundred pounds of grapes yield on an average but seventy pounds of real wine, and as the water thus absorbed is retained in the must, eight to twelve per cent. in weight of the grapes constitutes from eleven and a half to seventeen per cent. of the wine. The quantity of water will be still greater if the vintage be held during rainy weather, as the rain will fall both into the vessels used for gathering and into the vats.

How great is the injury to the quality of the wine by this dilution of its alcohol may be seen by the following facts: One hundred pounds of grapes yield on an average seventy-five pounds of must. If then, for instance, there be twenty-four per cent. of sugar in the must of perfectly ripe grapes, those seventy-five pounds of must contain eighteen pounds of sugar. Now, if these grapes are gathered during a dew or rain, instead of seventy-five pounds there will be from eighty-three and a half to ninety-two pounds of must, containing only eighteen pounds of sugar.

Thus, instead of must of twenty-four per cent. of sugar, or one hundred degrees by Oechsle's must-scale, from which the best wine might be produced, the must thus obtained possesses only from nineteen and a half to twenty-one and a half per cent. of sugar, or from eighty-nine to ninety-four degrees Oechsle. The effect, however, of a few degrees, more or less, upon the quality of the wine is well known to every sensible vintager who has examined his wines by the must-scale, and compared the different results with their various values.

If now experience teaches us on the one side that perfectly ripe grapes contain everything in the proportions which, without alteration, are requisite for the manufacture of the most valuable wines, and if the external condition of the grapes evidence that only the ripest should be collected and during warm sunny hours, then, on the other side, a rainy vintage of but half-ripened grapes would be of injury to the must, because the disproportion of the excess of existing acid to the water and sugar will thus, if not corrected, prove much more hurtful than a lower proportion of sugar. On this account the considerable quantity of water required to be added to the must in unfavorable seasons, during which the grapes remain sour, ought to have long since suggested the propriety of contributing to the sour must the amount of water which is wanting.

To ascertain how much water good must does and ought to contain, let one hundred ounces of it be carefully evaporated until, after repeated weighing, no further diminution of weight is perceived. The remains contain all the non-volatile constituents, such as sugar, acids, salts, lees, &c. Now, if these remains amount to twenty-four ounces, as is the fact in good must of twenty per cent. of sugar, one hundred ounces of must will contain seventy-six ounces or per cent. of water, this being proved by numerous experiments to be the usual rate in such must, while seventy-three and a half per cent. has been shown to be the least, and seventy-seven per cent. the greatest quantity.

OF THE SUGAR CONTAINED IN THE GRAPE AND THE MUST-SCALE.

The peculiar kind of sugar held in solution in the juice of the grape is found in the raisin, in the solid form of little white grains. It is the same that we see as solid granular substances in honey when candied.

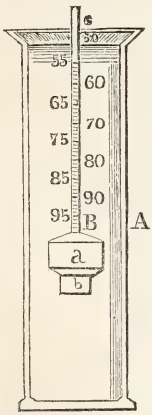
Grape-sugar differs from cane and beet-root sugar in appearance, forming, when dry, a crumbling mass of irregular grains, and hence it is called crumb-sugar. The same kind of sugar exists also in the juice of many other plants, cherries, figs, &c., and hence it is also known as fruit-sugar. It is not so sweet as cane-sugar, as may be proved by tasting a little dry grain from a raisin, and an equal small particle of cane-sugar ; one ounce of the latter being equal in sweetness to two and a half ounces of the former. There is also a difference in their solubility in water, grape-sugar being much more difficult and slower of solution than ordinary sugar ; one ounce of cold water will dissolve three ounces of cane-sugar, and but two-thirds of an ounce of grape-sugar. In boiling water, however, it is soluble in all its proportions.

The spirit and vigor of wine depends upon the quantity of sugar in the must, as alcohol is formed from the sugar by the vinous fermentation ; and though grape-sugar contains but two-fifths of the sweetness of common sugar, yet almost the same quantity of alcohol is produced from equal weights of either kind of sugar, that is, one pound of alcohol from two pounds of sugar in a dry state. (See a succeeding portion of this article, on "Alcohol.")

Sugar is formed in grapes during their ripening only, and, in all probability, by the conversion of other ingredients, especially acids. Its quantity increases in proportion to the degree of their ripeness ; this, however, depends on the intensity and duration of the heat of the sun during the process of their ripening. (See a succeeding portion of this article, on the "Acids.")

The greatest quantity of sugar observed in the best varieties of grapes—the Riesling, Traminer, Rulânder, Muscatel, and Black Burgundy—in the warmest years, the best situations, and in this climate, (Treves,) is from twenty-eight to thirty per cent., while in more southerly regions fifty per cent. is not unusual.

Several means are employed by the chemist to determine accurately the quantity of sugar in grape juice. They require, however, too many details to be economically used during the busy time of the vintage. At its close, therefore, an instrument is made use of similar to the well-known brandy-scale, which sinks deeper into fluids the less sugar they contain, or the thinner they are. The most suitable gauge invented for this purpose is the must-scale by Oechsle. It is made of silver, or German silver, instead of glass, more liable to break. A represents a hollow glass cylinder, for want of which use a beer glass filled almost to the brim with must, in which place the must-scale B. This scale is composed of the hollow float a, which keeps it suspended in the fluid ; of the weight b, for maintaining it in a perpendicular position, and of the scale c, divided by small lines into from fifty to one hundred degrees.* Before the gauge is placed in the must the scale should be drawn several times through the mouth, to moisten it, permitting, however, no saliva to adhere to it. When the gauge ceases to descend, note the degree to which the scale has sunk ; after which, press it down with the fingers a few degrees further, and on its standing still again, the line to which the must reaches indicates its so-called weight, expressed by degrees.†



Oechsle's Must-Scale.

Now, if there were nothing but sugar in solution in the must, its quantity could be easily ascertained by the scale, with the aid of the tables of pure solutions of sugar, which can be obtained. But besides there are other substances in must, such as acids, salts, adhesive substances, &c., which, though not in the same proportion as the sugar, contribute to thicken the must and prevent the gauge from sinking, so that these tables will not answer. To find the requisite data for the preparation of such a true table for must, I have had chemically and accurately examined as to their actual quantities of sugar a great number of musts of 1851, '52, and '53, of different degrees, and have arranged the results in the following table, according to Oechsle's must-scale. One of these comparisons, arranged according to Oechsle's must-scale, of the results obtained in the year 1851, and the estimates founded on them, I have already given in a

* Must of a lower quality, not having been formerly deemed worthy of a close examination, no regard was paid to it in the arrangement of the must-scale. At present, however, scales are made for must below fifty degrees, and such should be particularly designated, when ordered.

† The scale indicates also the specific gravity of the must, for, assuming the weight of pure water to be 1.000, the degrees on the scale correspond to the two last figures, by which the specific quality of fluids is expressed, for instance, 60 degrees on the scale = 1,060 of specific gravity.

former work on middling wines. Later researches in the two following years have partly confirmed the former ones, and partly several of the earlier estimates. In repeating here those tables for Oechsle's must-scale, I will also only remark that, owing to the error of the press, the quantity of sugar given in the earlier ones for the 61st, 62d, and 63d degrees of the must-scale was set 1 per cent, too high.

Table adapted to Oechsle's must-scale.

Degrees of the must at 14° R.=63°.5' Fahrenheit.	Quantity of sugar contained in 1,000 tariff pounds of must.	100 Russian quarts of must weigh.	Degrees of the must at 14° R.=63°.5' Fahrenheit.	Quantity of sugar contained in 1,000 tariff pounds of must.	100 Russian quarts of must weigh.	Degrees of the must of 14° R.=63°.5' Fahrenheit.	Quantity of sugar contained in 1,000 tariff pounds of must.	100 Russian quarts of must weigh.	Degrees of the must of 14° R.=63°.5' Fahrenheit.	Quantity of sugar contained in 1,000 tariff pounds of must.	100 Russian quarts of must weigh.	Remarks.
	Tariff pounds.	Tariff pounds.		Tariff pounds.	Tariff pounds.		Tariff pounds.	Tariff pounds.		Tariff pounds.	Tariff pounds.	
a	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*	
38	5.9	236	56	10.0	229	74	15.0	243	92	20.07	247	One tariff pound = ½ kilo-
39	6.1	......	57	10.2	......	75	15.3	......	93	21.1	......	gramme = somewhat over
40	6.3	......	58	10.5	......	76	15.6	......	94	21.4	248	1-10 pound English.
41	6.5	......	59	10.8	......	77	15.9	......	95	21.8	......	The columns *c c c*, which
42	6.7	......	60	11.1	240	78	16.2	244	96	22.1	......	indicate the absolute weight
43	6.9	......	61	11.3	......	79	16.5	......	97	22.4	......	of 100 Russian quarts of must
44	7.2	......	62	11.6	......	80	16.7	......	98	22.7	249	in tariff pounds, have been
45	7.4	239	63	11.8	......	81	17.0	245	99	23.0	......	added for facilitating the cal-
46	7.6	......	64	12.1	241	82	17.3	......	100	23.4	250	culations of the additions of
47	7.8	......	65	12.4	......	83	17.7	......	......	......	......	sugar required, which will
48	8.1	......	66	12.7	......	84	17.9	......	......	......	......	be the subject of future re-
49	8.4	......	67	12.9	......	85	18.2	246	......	......	......	marks.
50	8.6	238	68	13.2	......	86	18.6	......	......	......	......	
51	8.8	......	69	13.5	242	87	18.9	......	......	......	......	
52	9.1	......	70	13.8	......	88	19.2	......	......	......	......	
53	9.3	......	71	14.1	......	89	19.6	......	......	......	......	
54	9.6	......	72	14.4	......	90	20.0	247	......	......	......	
55	9.8	239	73	14.7	243	91	20.04	......	......	......	......	

The respective quantities of sugar, as shown by the preceding table, in sixteen cases, is the uniform result of accurate researches by two different methods upon must of 1851, reaching from 38 to 89 degrees of the must-scale.

In the other cases the quantity of sugar has been determined in accordance with the above results. The degrees marked A and B indicate that the same results have also been obtained in 1852 and 1853, respectively. It is indeed doubtful whether this table can be applied equally to the must of all sorts of grapes and of all localities; because the amount of extractive principle not including sugar, as shown by previous researches, varies from $1\frac{1}{2}$ to $4\frac{1}{2}$ per cent., so that it is possible a must may actually contain a little more or less sugar than is given in the table. Still it may be the more relied on, as it is at the present time conceded that the quality of wine generally depends not so much on a definite amount of alcohol (the proportion of sugar in the must) as on a certain moderate quantity of acids.

It is further observed—

1. That the must should be weighed in an entirely fresh state, and before it exhibits any sign of fermentation.
2. That it should be filtered, before weighing, through a linen cloth.
3. That, before examination, it should be brought up to a temperature of 14° R. = 63.5

Fahrenheit—the glass containing the must, with the thermometer placed in it, being held for a short time in warm or cold water.

At the conclusion of the section on water, it was mentiened that a good must of 20 per cent. of sugar contains, on an average, 96 per cent. of water; and, after evaporation, it leaves a deposit of 24 per cent. of extractive matter, including all the non-volatile parts contained in the grape juice. But the sugar contained in it, so long as it is held in solution in the water of the grape, as a diluter of the acids, occupies exactly the same fluid space as the water itself with which it forms sugar-water. Hence it follows that a good must, in reference to the just proportions of acids, contains not 96 per cent. of water and 20 per cent. of sugar, but rather 96 per cent. of sugar-water; yet that this accordingly, as our object is to produce more or less fiery wine, may consist of more or less sugar or water, respectively, of which we shall treat in its place.

OF ARTIFICIAL GRAPE-SUGAR.

Grape-sugar is artificially produced from the starch (flour) of the potato, and hence it is also called Starch-sugar, or Potato-sugar. It has the name of grape-sugar as being not only actually similar to the sugar naturally present in the grape, but also because it is exactly the same in all respects both as to its chemical composition and the quantity of alcohol produced from it by fermentation. It is, therefore, better fitted to the improvement of must that is deficient in sugar, as it is from 25 to 30 per cent. cheaper than cane or beet-root sugar, even at the high prices of potatoes at the present time.

Artificial as well as natural grape-sugar is a compound of six parts of oxygen, six of carbon, and six of hydrogen, while common sugar is composed of five of oxygen, six of carbon, and five of hydrogen. This difference is an important one, as chemistry shows us that common sugar, to become capable of passing into alcohol and carbonic acid, has to receive from the must during its fermentation one part of oxygen and one of hydrogen, of which, as compared with grape-sugar, it is deficient. This, too, explains the fact that some percentage more of alcohol may be formed from cane and beet-sugar than from an equal weight of grape-sugar.

The artificial grape-sugar of commerce is seen in different forms:

1. As a thick fluid or syrup, differing in its amount of sugar, and therefore more or less thick or transparent, and also varying in color from white and of water clearness, light-colored, fair, up to brown.
2. Solid, but when fresh still more or less moist, nearly like very dry soap, from milk white to fair.
3. Dry, finely pulverized and crumbly, milk white, and light-colored.

Grape-sugar, when used for bettering must, should, above all, have a pure taste, and especially no bitter taste when a piece of it is dissolved in the mouth.

It ought also to be free of all dextrine. Sugar is not formed immediately from starch, but from a gummy substance called dextrine, or gum dextrine, which is fully converted into sugar by being continually boiled for a long time. If the process be interrupted too soon, part of the dextrine already formed will remain in the sugar. In case such sugar is used for the bettering of wine, the dextrine not having been converted, like the sugar, into alcohol, remains dissolved in the fresh wines, and imparts to it more or less mucilaginous quality, and thus renders its clarifying of greater difficulty. Besides, it has a smaller quantity of alcohol than it otherwise ought to have from the weight of the sugar added.

Grape-sugar for bettering of wine ought, therefore, to be closely examined before using it that we may be sure it is free of all dextrine.

The tincture of iodine, easily procured at a small price from a druggist, should, therefore, be kept always on hand. This is a dark-brown fluid, and has the property of coloring any solution of sugar which contains even the smallest quantity of dextrine a deep blue, while it imparts to a pure solution merely a shade of yellow or a light-brown color. Put a little sugar—say as much as can be held on the point of a penknife, or half a teaspoon full of syrup—into a small glass, add a teaspoon full of water, and should there be any dextrine or starch retained in the sugar or syrup, a few drops of the tincture of iodine will turn the white or yellow fluid blue.

The relative value of the different kinds of sugar depends, of course, upon the quantity of saccharine matter they contain. It would be well that this should be accurately stated in the Price Currents, so that wine-growers might be guided by it in calculating the additions of sugar they have to make. Until they are so aided, the following figures may serve them as a guide:

100 pounds of cane or beet-root sugar will contain of sugar free of water.	90–93 pounds.
100 pounds of dry grape-sugar will contain	89–90 "
100 pounds of solid grape-sugar will contain	80–84 " &c.

The quantity of sugar contained in the syrup, after the removal of every particle of dextrine, may be accurately determined by means of Balling's saccharometer. This is a gauge which, sinking to a greater or lesser depth in pure solutions, indicates the parts by weight of pure sugar in such a solution. For example, if the gauge sinks to the point of 75° in a syrup heated to 14° R., it shows that there are 75 pounds of pure sugar in 100 pounds of the syrup.

When one has not Balling's gauge, Beaumé's may be used. At a temperature of the syrup of $12\frac{1}{2}$ Reaumur, = 60 Fahrenheit, the following degrees of this gauge show the proportion of sugar according to the percentage of weight:

33	degrees for	61.5	per cent.
34	"	63.3	"
35	"	65.2	"
36	"	67.1	"
37	"	69.0	"
38	"	71.2	"
39	"	73.6	"
40	"	75.0	"

Syrup, however, of a darker color than fair (light-colored) and likewise of pure taste, without any dextrine, can be used for red wines only.

The following are the names of the firms engaged in the manufacture of grape-sugar already in operation in Prussia:

1. H. V. Bertog, at Wolmirstädt, on the Ohre, (Comptoir at Magdeburg.)
2. Lohburger Manufactory, at Magdeburg.
3. Friedrich Wahe, at Neuwied.
4. Premy & Espenscheit, at Newnied, in Hesse.
5. Best Brothers, at Osthofen, near Worms.
6. Dr. C. W. Philippi, at Jngenheim.
7. Deisz & Co., at Offstein, near Worms.
8. Fritz Muth, at Neunükle, near Westhofen.
9. N. Hoffman, at Jngenheim.

OF THE ACIDS AND THE METHOD OF DETERMINING THEIR QUANTITY IN THE MUST.

The acids contained in the grape juice are either *free* acids or combined with earths and alkalies, forming with them partly acid, partly neutral salts. (See the section below on salts.) It is only the free acids, and those contained in acid salts, that are known by their taste; the existence of these in wine, according to their quantity, can only be shown by means of a saturation with a base.

Aside from the fact that the deliciousness of wine mainly depends on its proportion of acids, they are also said to exert an essential influence on the formation of peculiar combinations, and hence, also, on the development of the aroma. In support of this opinion it has been contended that those wines which contain much acid, like the Rhine wines, will, in especial degree, show a strong bouquet, while it is alleged that in the Southern wines, containing less acid, this quality is almost entirely wanting. Others, likewise, have appealed to this alleged fact in order to combat the propriety of diluting even the excess of acid. But if it be true that "wines containing much acid develop a richer bouquet," why is it that most of the wines of Austria, Styria, and many of those of Hungary, which contain still more acid than the Rhine wines, exhibit no bouquet whatever? And if by "much acid" we are to understand a surplus of acid, how is it that Rhine wines also, of unfavorable years, instead of being the richest in bouquet, exhibit none or but little of this peculiar quality?

Were this opinion true, even as to such wines only as have a bouquet-matter, like the Rhine wines, the expression "*much acid*" could evidently mean nothing but "*so much acid*" as such wines contain in the most favorable seasons.

But, in the opinion to which we have referred, the expression "bouquet" has been confounded with "flavor," (taste,) which belongs in a much higher degree to all wines containing a larger quantity of acid than it does to the Southern wines. In this respect, also, such a quantity only of acid as is possessed by those wines of the most favorable seasons can be supposed to influence the development of the flavor, else the over-acid wines of unfavorable years would possess the strongest flavor.

The conclusions, therefore, for reducing the surplus acid of the must to a standard of good years are the more self-evident, as for a long time, and in a greater degree than is publicly known, it has been thought useful to employ chalk, potash, &c., for a partial removal of the superabundant acid.

Chemists distinguish the acid of the grape as the vinous, malic, grape, citric, tannic, gelatinous, and para-citric acids.

1. Whether or not besides vinous acid (free and combined) there are so many other different kinds of acids as above named, or which of them are really contained in the grape, is not yet fully ascertained, since some chemists profess to have found in it acids which others have not, and as the paracitric acid is but a recent discovery. For the practical part of wine-making it is, however, sufficient for us to know, with full certainty, that as the grape ripens, while the proportion of sugar in it increases, the quantity of acid is continually diminishing, and hence, by leaving the grapes as long as possible on the vine, we have a double means of improving them.

2. That all wines, without exception, to be still good and of agreeable taste, must contain from 4½ to 7 thousandths part of free acids, or, more scientifically expressed, only such a quantity of free acids as can be saturated with 4½ or 7 thousandths of the solution of caustic ammonia of 1.369 per cent.

3. Each must containing more than seven thousandth parts of free acids may be considered as having too little water and sugar in proportion to its quantity of acid.

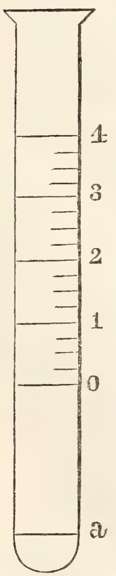
4. In all wine-growing countries of Germany, for four years past, experience has proved that a corresponding addition of water and sugar is the means of converting the sourest must not only into a good wine for drink, but also into a wine as good as can be produced in favorable years, except in that peculiar aroma found only in wines made from perfectly ripe grapes.

5. There is now a simple and reliable method, applicable to general use, of determining the quantity of acids in the must, (and wines,) even to the one-tenth thousandth part, and also, with the same accuracy, the quantity of water needed in any poor must to make it equal to that of a good season.

A peculiar property of vinous acid likewise deserves mention, viz: that if diluted with much water, or mixed with only a little alcohol, it is in time converted into acetic acid. This fact explains their want of capacity for keeping in the poor wines of unfavorable seasons.

Acetic acid does not exist in the grape. It is nothing but oxydized alcohol, and is, therefore, only formed after alcohol has been generated by fermentation. Some further remarks on this head will be found below.

THE ACETOMETER AND ITS USE.



Otto's Acetometer.

The Acetometer invented by Dr. Otto, to examine vinegar, consists of a glass tube from ten to twelve inches in length, half an inch in width, and closed at the lower end.

This tube is filled up to the partition line **a**, with tincture of litmus. The must to be examined, after it has been filtered and before it has begun to ferment, is then poured into the tube until it reaches the line 0.

The blue tincture of litmus, which, if water had been added would still have been blue, is turned into rose color by the action of the acids contained in the must.

If a solution 1.369 per cent. of caustic ammonia is now added to this red fluid, turning the tube round to effect the necessary mixture, keeping its mouth closed with the thumb, after the addition of more or less of the ammoniacal fluid, it will be seen to have changed it into violet. This tinge indicates the saturation of the acids, and the height of the fluid in the tube now shows the quantity of acids in the must, by whole, half, and fourth parts per cent.

The lines marked 1, 2, 3, 4 indicate whole per cents.; the short lines between them, fourths of a per cent. These subdivisions on the acetometer, double the size they are in the cut, may be divided again by the eye into fifths, so as to show the quantity of acids most accurately, even to one half per cent., or one-half of a thousandth.

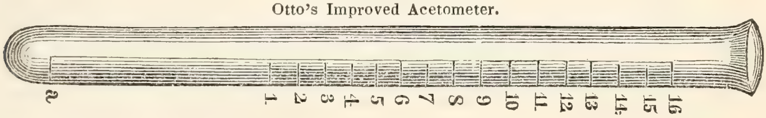
It is true that if must or wine be examined by this instrument the quantity of acids appears to be larger than is shown on the scale, because such acids require for their saturation a weaker solution of ammonia than acetic acid. But when, shortly before the vintage of 1850, I first publicly recommended the dilution of the acids, there was no time for inventing a particular instrument by which to determine the quantity of acid. I was therefore obliged, even at the risk of leaving a little too much acid in the must, to refer to an instrument well known and everywhere at hand, especially a cheap one. As, however, Otto's acetometer shows about one-eighth less of acid than the must actually contains, and about as much acids combined with earths is removed during fermentation, I recommend that the quantity of acid be reduced to 6½ or at most to 7 thousandths of Otto's acetometer.

This suggestion, dictated by necessity, has proved entirely applicable in thousands of cases and on a large scale; so that the proportion of acid best adapted for good middling wines is that contained in must requiring for its saturation from 6½ to 7 thousandths of the testing fluid of 1.369 of ammonia, according to Otto's acetometer. In other words, those wines where the acids (in the must) had been reduced, by added solution of sugar, to from 6½ to 7 thousandths, were in favor with all consumers, except, however, that in such countries as grow none for themselves, wines of 6½ thousandths of acid, or even containing somewhat less alcohol, have almost universally the preference.

The acetometer above referred to needed therefore only a more convenient construction. This it afterwards received by making its diameter a little smaller and giving the divisions one-half more width—that is, making them of one-tenth instead of one-quarter per cent., and thus dividing the whole space above 0 into thousandths, and gaining for each thousandth an equal space on the scale as had been allowed to a fourth per cent. in the former instrument. But though by this improved acetometer the quantity of acid could be determined up to one-third, one-fourth, and even to one-fifth of a thousandth, yet there was the same defect as in the former one, that in often turning about the glass tube for mixing the fluids some of the contents—not less, in all, than one-half of a thousandth part—might adhere to the thumb closing its mouth.

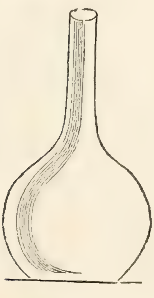
This defect has been remedied in a new acetometer by Mr. Geisler, mechanic, the ingenious inventor of the Vaporimeter for the determination of the quantity of alcohol contained in wine. Chemically, it is based on the same principle as Otto's, but differs altogether in its construction. It is composed of three parts, all made of glass, and put up in an appropriate case—price 2 thl. 15 sgr. Prussian (about $2.)

Otto's Improved Acetometer.

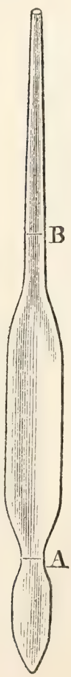


GEISLER'S NEW ACETOMETER.

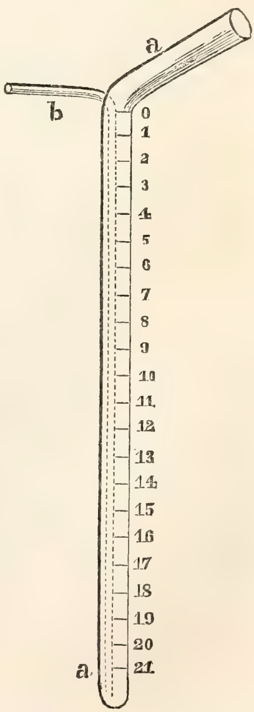
Mixing Bottle.



Ripette Pipe.



Burette.



Besides this instrument, there should be ready three small glasses, one filled with tincture of litmus, the second with a solution of 1.369 per ammonia, and the third with the must or wine to be tested; likewise, a taller glass or other vessel having its bottom covered with some cotton, in which glass or vessel the burette, after being filled with a solution of ammonia, is to be placed in an upright position until wanted.

The following is the mode of using this instrument: After the must and the tincture of litmus have received the normal temperature of 14° Reaumur, the quantity required of both substances is brought into the mixing bottle by means of the pipette, which is first filled to the division line A with the tincture, and after this tincture has been emptied into the bottle, the pipette is again filled with must to the line B. To fill the pipette, place its lower end in the glass containing the tincture or the must, and applying the mouth to the upper end, gently cause the fluid to ascend above the line before mentioned. The opening at the top is then quickly closed with the thumb. By alternately raising the thumb and pressing it down, so much of the tincture of litmus or must is allowed to flow back into the glass as shall lower these fluids to the lines A or B, respectively. In bringing them into the bottle the last drops must be forced out by blowing into the pipette.

Holding the smaller tube of the burette in the right hand, it is brought into the vessel containing the solution of ammonia, while, by applying the lips to the mouth of the larger tube and drawing in the fluid, this tube is filled exactly to the line 0 of the scale.

Now, holding the mixing bottle by the neck between the thumb and first finger of the left hand, place the smaller or dropping tube of the burette into the mouth of the bottle, which must be constantly shaken; let enough of the solution of ammonia thus be brought, drop by drop, from the burette into the mixture in the bottle, till the red begins to change into blue, or till it has been converted into the deep reddish blue of the purple onion. This tone of color is the proper sign of the complete saturation of the acids. To distinguish it still better, turn the bottle, keeping its mouth closed with the thumb, and examine the fluid in the tube-shaped neck of the bottle, and afterwards, if required, add to it another drop of the solution of ammonia. This operation is to be repeated until the proper tone of color, neither red nor blue, has been reached. If some of the fluid should adhere to the thumb, it will not affect the result, as the quantity of the solution of ammonia used and marked on the scale of the burette shows the quantity of acid.

After thus fixing the precise point of the saturation of the acids the burette is held upright, and the quantity of the solution of ammonia consumed is accurately determined—that is, to what line on the scale the burette has been emptied. The quantity of the solution so used corresponds to the quantity of acid contained in the must or wine, the larger division lines opposite the numbers indicating the thousandth parts, and the smaller lines or dots which divide the space between one figure and another into ten subdivisions marking the ten-thousandth parts. If, for instance, the testing fluid, or solution of ammonia, has in any experiment been consumed to the third small line below figure nine, the quantity of acid thus marked 9, 3, is nine three-tenths thousandths.

Until the eye has learned from practice to recognize the points of saturation by the tone of color, it may be well to undertake a series of provings for the purpose of fixing the results testing the must or wine already examined by means of litmus paper. When the mixture in the bottle begins to turn blue put in the end of a slip of litmus paper to the depth of one-half inch, and then draw this end through the thumb and first finger, moistened with water. As long as the acids are not completely saturated the end of the blue litmus paper dipped into the fluid will appear more or less REDDENED. Not until it ceases to exhibit this appearance, or till the test paper remains blue, after being wiped off, will the point of saturation be reached.

In examining RED must or wine the method is to be modified as follows: instead of filling the pipette with tincture of litmus, first fill it with water up to the line A, and then transfer it into the bottle. After the quantity of must or wine needed has been added, drop six-thousandths of the solution of ammonia into the mixture, constantly shaking it while it is dropped, then test it, and so on, after every further addition required with litmus paper, until it shall no longer be reddened after it has been wiped off.

SALTS.—Salts are combinations of an acid with a base. If such a compound, for example, kitchen salt, or tartar, is dissolved in a liquid, and the solution left standing in a warm place until the liquid is evaporated, the salt remains in the shape of small crystals.

The salts held in solution in must and wine are very different, according to the constituent parts of the soil in which the grapes are grown. Besides bitartrate of potassa, or the so-called tartar of wine, the following substances have up to this time been discovered in the grape: sulphate of potassa, sulphate of soda, muriate of lime, sulphate of lime, phosphate of lime, nitrate of lime, tartrate of lime, hydrochlorate of soda, (kitchen salt,) potassa tartrate of alumine, (Weins aure-kali-Thonerde.)

The same variety of grapes, in addition to the tartar of wine, abounding in all kinds,

according to the diversity of the soil where they grow, may, therefore, contain also more or less of salts of one or the other description. Is there not here another proof that none of the salts do of necessity form a constituent part of a good wine, that many do not belong to wine at all, and that even the best grapes may contain substances that at least are not indispensable to the production of wine, else it would follow that perfectly ripe grapes of the same variety must at least contain the same salts in the same quantity?

Those salts, however, like many other substances, not only are not necessary to the production of wine, but if present in it in large quantities, certainly have an injurious effect on the taste of the wine.

The dilution of the superfluous acids in the must, by a suitable addition of water and sugar, will likewise in this respect be attended with a better effect, for two reasons: 1st, the injurious salts are thus distributed over a larger quantity of liquids; 2d, in proportion as sugar is added and alcohol produced a larger quantity of salts is separated, because they are only soluble in water, and not in alcohol, so that in a given quantity of liquids the less salts remain dissolved the more alcohol it contains.

A large proportion of salts in grapes is always owing to a large quantity of salts in the soil or to the manures applied. Especially injurious to the taste of the wine are the salts of grapes grown on a soil containing much nitrate of potassa, nitrate of lime, talcose earth, and ammonical salts. The amount of sugar contained in such grapes, even if the wine requires no other improvement, should always be increased to 28 or 30 per cent., in order to remove the greater portion of the injurious salts by the increase of the quantity of alcohol.

The chief utility of some salts, for instance, tartar, (kitchen salts,) sulphate of soda, (Glauber's salt,) is said to consist in imparting to the wine laxative and aperient properties. Admitting this, those wines can only possess such a property in which these salts are actually present. And in many of the best wines several of these salts, with the exception of tartar, which is found in all, are either entirely wanting, or exist only in such small quantities as will hardly admit of being determined; their presence, in a certain definite proportion, can evidently have no effect upon the quality of the wine as a beverage. Were it so, the wines in the hotels, for the benefit of their consumers, would require to be labelled or assorted very differently. Instead of Johannisberg, Liebfrauenmilch, &c., of such and such a year, it should read wine of such an amount of tartar, Glauber's salt, &c., or wine of aperient properties to such and such a degree.

The above remarks, however, must not be construed as if the dilution of the acids may also be followed by a dilution of the salts, which perhaps might be less beneficial, for it has been acknowledged by Dr. Böcker, one of the most competent authorities in matters relating to health, "that no substance conducive to health is removed from the wine by an addition of sugar and water before the commencement of fermentation." My remarks have been directed only against the assertions of some interested speculators, who attach a special value to the constituent parts that are of mere incidental occurrence.

GUMMY AND MUCOUS SUBSTANCES.

These substances might likewise be readily dispensed with, but in wine-making we have to take up with them in common with those ingredients that are useful and indispensable in the juice of the grape.

The mucous matter nowise adds to the quality of wine, which even seeks to get rid of it, partly by removing it during the process of fermentation, and partly by separating it at a later period, together with the tartar. It appears, therefore, that the presence of these gummy substances, which are to a considerable amount found in many of the musts, renders the clarification of the wine difficult, and so it would be well to remove them before the fermentation begins. This is partly done by the process of freeing it from the mucous matter, by which, if properly done, some of the other substances not destined by Nature for the production of wine are separated, as well as all unclean matters which may have come from without into the must.

The same applies to the gelatinous acid, a portion of which is likewise separated with the lees, while another portion, in connexion with superfluous alkali (potash) and alkaline earths, (lime, &c.,) with which it enters into insoluble combinations, settles in the water. This useless substance is likewise removed by the process of freeing it from the mucous or gummy and mucilaginous substances.

COLORING MATTER.

I know of only one variety of grapes, the dyer's grape, (*Vitis tinctoria*,) the juice of which is red-colored. In all other red, blue, and black varieties the bluish-red coloring matter is contained only in the skins, or husks. It is of a resinous nature, and therefore insoluble in the must so long as no alcohol has been formed. For this reason the blue and red grapes will produce only white wine, where the must is not allowed to ferment together with the skins, in which case the coloring matter is dissolved by the alcohol formed during the process of fermentation. The more thoroughly this is done the darker is the color of the wine, the richer the must is in sugar, and hence the more alcohol is formed the longer the wine is left in contact with the skins. The color, too, appears the darker the less acid the wine contains, as the acids change the deep reddish-blue color into red. An addition of water not too large with sugar to correspond not only does not at all deprive the red wine of its color, but rather gives it a darker shade.

The coloring matter, brought frequently into contact with the air, oxydizes, becomes brownish-red, and gradually separates from the wine. Red wines, therefore, should be transferred from one cask into another only by means of a leather pipe and bellows. By the addition of some vinous acid, however, the change of the color can be checked and the former hue restored.

The green color of the juice of the white and yellow grape is derived from a substance present in the juice as well as in the skins, and which is called leaf-green, or Chlorophyl. That the green must produces wine varying from a more or less light to a dark yellow color is owing to the greater or less quantity of lime in the soil on which the grapes are grown.

The dirty-looking, dark-yellow color assumed by many white wines after a long contact with the atmosphere is most probably owing to the oxydation of nitrogenous compounds, (gluten, animal and vegetable substances,) and also where much mucilage exists, which prevents the oxydized substances from settling, it is the remote result of an imperfect fermentation, for nothing, or as little as possible, that does not belong to the wine should remain after a properly conducted fermentation.

The fact that the gummy substances prevent the particles suspended in the liquids from settling is easily shown ; for example, if we have black ink prepared without gum, it must be shaken every time before it is used, because of its black coloring always settling at the bottom. This shaking, however, is unnecessary, if we add to the ink a few drops of a solution of gum, by which those substances are kept suspended.

OF TANNIN.

This is a substance of a peculiarly astringent taste, which is important in the making of wine, because it frees it from a number of those substances, partly useless and partly injurious, that are contained in the must. In the grape the tannin is present, especially in the seeds, skins, and stalks.

Tannin, therefore, enters into wine when grapes are so much pressed as partially to mask the seeds and stalks, or when the must is allowed to ferment with the seeds, skins, and stalks. Tannin is easily dissolved in water, and consequently in must, while it has the property of forming insoluble compounds with animal substances, (existing in the must in the form of animal and vegetable substances, albumen, gluten, and lees,) and thus often settling in the shape of leather-colored lumps of the size of the fist.

While a large portion of it, together with the substances referred to, or at least a part of them, is separated during fermentation, the remaining portion can easily be removed by adding and intimately mixing with the wine a sufficient quantity of milk, albumen beaten into a froth, or dissolved isinglass, lime, &c. By this method wine is clarified, or, as it is said, refined, in those cases in which the turbid wines still contain some tannin. If tannin be wanting, and its turbid character is owing to the presence of gummy substances, then, on the other hand, a solution of tannin must be added to the wine to be refined. An addition of tannin is also an approved remedy against the grease-disease of wine. The greater the amount of tannin in red wines fermented together with stalks, skins, and seeds, or even skins and seeds alone, seems to be the reason why they are generally preferred as a common beverage in Southern wine-growing countries to the white wines containing a greater amount of tartar. The effect of the high temperature of those countries in relaxing the muscles would become greater by the frequent use of a beverage containing much tartar and of a laxative character, while tannin tends to produce a greater contraction in the muscular system than any other substance in daily use.

The Northern man, on the contrary, whose tension of muscles is naturally much greater,

requires in his drink something that quickens the blood and promotes its circulation, rather than an astringent. And this is done by the alcohol in the diluted state, such as is found in good wines.

NITROGENOUS COMPOUNDS AND FERMENTATION.

The nitrogenous compounds (vegetable albumen, gluten, &c.) are among those ingredients in the juice of the grape, abundant in the unripe fruit, which serves as the first nourishment for the germ of the plant contained in the seeds, and which may likewise be important for the production of wine, but in a great measure unnecessary in wine already made. These substances dissolved in the must as completely as the sugar, under certain circumstances turn into the fermenting principle (yeast, barm,) and so become capable of changing the must into wine, a fluid of a wholly different character in its smell and taste, and sometimes intoxicating qualities.

These changes are wrought by fermentation, and this is excited, caused and sustained by a portion of the lees being converted into the fermenting substance. This substance is only gradually so changed, and in proportion as it oxydizes, or receives oxygen from the air, in consequence of which it coagulates, and shows itself in a turbid state of the must or young wine. The oxydation of the lees takes place but gradually, and just in the degree the exhausted lees settle, so that the process of fermentation must be kept up by the constant supply of new lees. For it is a mistake to believe (a fact I wish to urge here particularly) that all the fermenting substance, or such as produces lees, yeast, is removed by an after fermentation, or by a second racking-off of the wine. It is only the yeast-matter which has coagulated by means of the oxygen received which has settled, and all German wines, even after becoming very light, still contain a considerable portion of this substance. All white wines of unfavorable seasons, even after two or three years, appear to contain a larger portion than would be required to decompose double the amount of sugar possessed by the must. For this reason the German white wines of inferior seasons begin again, even after some years, to move, or work, during the warmer season, actually undergoing a second fermentation, becoming more or less turbid, and forming new sediment. With the increasing temperature of the atmosphere a change of air is constantly taking place in the cask, the heat of the day rarefying the wine, and expelling from the empty space the air already partially deprived of its oxygen. Through the coolness of the night the wine is again thickened and condensed, thus admitting fresh air, by means of which new oxygen is received, and new lees are formed of the material already existing for this purpose.

There is much less lees matter left in red wines after fermentation, because they are allowed to ferment together with the stalks, or, if the berries have been picked, at least with the seeds, and the tannin extracted from the latter settles, with a corresponding quantity of yeast matter, in the shape of an insoluble compound. Red wines, which have become settled, and have fully undergone fermentation, and have been kept in contact with the skins and seeds for several months, will never work again after their first drawing off.

It is the same with wines made from Southern grapes containing a great proportion of sugar, a large quantity of which remains undecomposed after the smaller proportion of their nitrogenous substances has coagulated and completely separated in the shape of lees.

Wines in which the whole of their sugar has been decomposed are called *sour*, or *dry* wines. Those still containing a large quantity of undecomposed sugar are called *sweet*, or liquor wines.

The lees-matter remaining in the wine after all the sugar has been decomposed has the same effect upon the alcohol formed in the wine which it previously had upon the sugar ; for in the same degree as it turns into lees by contact with oxygen, the alcohol tends to combine with the oxygen to form acetic acid. Fortunately this change can take place only to a limited extent, on account both of the cold temperature of good wine cellars, and of the slight change of air confined within the walls of the casks.

FRAGRANT OR FLAVORING SUBSTANCES.

Besides the peculiarly agreeable wine flavor of all wines made from grapes, and by which they are distinguished from all other wines made of orchard fruit and berries, there is still another peculiar fragrance developed in some wines made from particular varieties of grapes. This odor resembles the fragrancy of the grape blossoms, and is known as aroma, flavor, or bouquet of the wine.

Neither the general flavor of the wine nor the bouquet is present in the must, but the matter or substance exists there, from which these are developed during fermentation and in the cask. The former, the characteristic flavor of the wine, is owing to a fatty acid dis-

covered by Liebig and Pelouze, and which has been named by them Oenanthic acid or Oenanthic ether, as it always occurs in connexion with ether.

Dr. Winkler (a chemist distinguished for his explanations of the process of vegetation) has succeeded in throwing new light on the origin of the bouquet. He obtained from a wine of a rich bouquet a peculiar nitrogenous compound, in the shape of a neutral salt, which possessed in the highest degree the flavor of the bouquet of the wine used. He therefore draws the conclusion that ripe grapes furnish a delicious bouquet, whilst unripe grapes produce a repugnant one. Wine even from the so-called bouquet grapes, which have become fully ripe, not only are wanting in the bouquet, but, what is still worse, they possess a very unpleasant smell. Since, therefore, some grapes do not fully ripen even in the best seasons, and as others do so even in the worst ones, the agreeable and valuable bouquet of favorable years, by throwing the ripe and unripe grapes together into a basket or pot, is injured in two ways: First, that instead, for example, of 100 per cent., only 90 per cent. of a fragrant bouquet is obtained; and, secondly, that, in the place of the 10 per cent. of this agreeable bouquet, still wanting, there is 10 per cent. of a disagreeable one, which will neutralize at least the same amount of the former; so that by pressing 10 per cent. of unripe grapes together with 90 per cent. of ripe ones, the wine loses one-fifth part of its fragrant bouquet. In poor and inferior years, when the ripe grapes may amount only to from 10 to 30 per cent. of the whole vintage, the agreeable bouquet is thus wholly lost in the disagreeable one.

As the price paid for bouquet wines is not always in proportion to the fineness of the aroma, but as wines of the same locality and year, with only one-fifth of a better bouquet than others, bring a price double and three times as high, it is easy to see what damage is done by neglecting to carefully pick out and assort the grapes, and leaving the best to the laborers as a part of their wages.

Besides, unripe grapes are always over-acid and poor in sugar. By adding to the must the requisite proportion of water and sugar, and diluting its acid, it is evident that the unpleasant smell of the bouquet will at the same time be diminished.

It is, moreover, probable that accurate experiments will show that the bouquet matter, as well as all the other constituents of the grape, is of the same condition, both in ripe and unripe grapes; and that the peculiarity of the bouquet to be developed depends in part on quantity of alcohol formed during fermentation.

This supposition is the more likely from the circumstance that wines from bouquet grapes of the same general condition, which are richest in alcohol, are also at the same time richest in a fine bouquet. This fact renders it further probable that the volatile alcohol, or the still more volatile ether formed from it, is the bearer of the bouquet fragrance, according to which idea too little bouquet fragrance may be developed, in case of there being too small a quantity of alcohol; while on the other hand, in case of too great a proportion of alcohol, the bouquet may be too soon exhaled. The following experiments almost give certainty to these conclusions:

Within two years wine has been made from the skins of grapes in several places by way of experiment. In some cases mentioned, when the autumn work was finished, the skins of the grapes, first drenched with water, were pressed, care being taken that after the small quantity of their sugar was decomposed, and they had passed into the acid fermentation, the sugar and water still needed should be supplied. The result was, that this wine from grape-skins (mostly of Riesling and Ruländer grapes) had more agreeable and richer bouquet than the wine obtained from fresh-pressed must, so much so that in one case a wine-producer was induced on this account to better his wine from must by mixing with it the wine from the grape-skins.

From this experiment it is clear that the bouquet matter, or at least a portion of it—as in pears, apples, apricots, and the fragrant plums—is contained in the skins or husks of the grapes, so that the must of the bouquet grapes should be allowed to ferment for a few days at least together with the skins of the picked berries.

THE EXTRACTIVE PRINCIPLE.

After the chemist has analyzed the juices or the extract of plants, and removed the substances more generally known as sugar, acids, salts, albumen, &c., and after he has carefully evaporated the water, there is left at last a brown substance uncrystallizable, and soluble in water and alcohol. This substance usually possesses in a higher degree the taste and medicinal virtues of the plant from which it has been obtained that has such properties. It is called the extractive principle, of which there are a great many varieties of different kinds—such as absinthin from wormwood, asparagin from asparagus, &c., &c., though there is no *œnin* or *œnonin*, as the extractive principle of the wine might be called, to be found in one of the shops. Still the single Department of Herault, in France, in which 200,000

casks (fuder) of wine are annually distilled, could supply the whole world with extractive principle at trifling prices.

This extractive principle has little or no influence upon the value and quality of the wine, or if it has any, as Mr. Liebig cautiously asserts, it is evident from the experiments of Geiger and Lüdersdorf, on a number of wines of different kinds and seasons, that it is not a perceptible one in respect to wines of luxury, and in a dietetic respect it has none except by a very trifling increase of acids in proportion to the other unvolatilized parts. According to M. Chaptal, the quality of wine increases in the same degree, and as its extractive principle is removed.

In chapter ix, § 4, of his celebrated work, he says: "The extractive principle always abounds in the must; but as the sugar is decomposed by fermentation, this principle likewise diminishes. A portion of it settles to the bottom, which is the greater in quantity the more alcohol has been formed. The extractive principle, therefore, is the chief ingredient of the so-called lees. It is this lees which is removed from the wine by drawing off or racking to prevent it from turning sour. There is a larger portion of lees present in fresh wines than in old ones, which are the more completely freed from it the older they are."

As now the wines increase in quality by age, the extractive principle is a hindrance to their betterment, and must first be gradually removed before they can attain their best quality.

It is generally known that on every drawing off, until the wine has obtained its greatest age, a new, though gradually lessened, sediment of lees is formed, consisting mainly of the extractive principle. We well know, too, that physicians prescribe only old wine to their convalescents, which further shows that the extractive principle is of no value as to diet.

From our examination of the ingredients of the juice of the grapes, and of their essential properties, we are justified in concluding that it is only the *acids*, the tartar, the lees material, *i. e.*, the substance producing lees and the tannin, abounding even in unripe grapes, and present to a great extent in the skins with water and sugar, (the proportion of which can and ought to be corrected in every must pressed from imperfectly ripened grapes,) that are indispensably necessary to the production of wine, and that a good middling wine, at least, may also be obtained from all grapes, however unripe they are in unfavorable seasons.

FERMENTATION.

In calling the fermentation which must has to undergo a spirituous or vinous fermentation, such conditions only have been brought into view as are necessary, in order that the sugar of the must may be decomposed as thoroughly as possible, and that as much alcohol and carbonic acid as can be may be generated. But the fermentation of the must is not so much for the purpose of the formation of alcohol as of wine. It can, however, only be called wine in that stage when it is free of all substances that do not belong to wine, and which render it liable to continued changes, and endanger its keeping properties.

By the present method of effecting the fermentation of must and preparing a fresh wine as an article of commerce that may be liable to no changes, it is likewise finally relieved of the substances above mentioned, but only by a very gradual process, and often, after a long series of years, more than doubling the cost of the wine for interest, loss, and the expenses of management. It is, however, the object of modern industry not only to produce a good, but a cheap article that is to save as much as possible of the capital, material, time, and labor.

The must should be made to ferment in the same degree of temperature in which it takes place in the warm native countries of the grape, and where this fruit ripens, and is pressed at the end of August and in the beginning of September. We have, however, the advantage of removing the wine, after it has passed the fermentation by which alcohol and wine are formed, into cool cellars, and thus of preventing the spirituous from passing into the sour fermentation after the sugar is decomposed.

Since the practice of gathering the grapes later has been generally introduced, and the fermentation has been made to take place during the cooler first half of November, some observing wine-growers, whose recollections reach back twenty or thirty years, have noticed that the wines undergo a far less complete fermentation, and that in the following year, and even in the fifth or sixth year in the warmer seasons (when the grape blossoms) after, the fermentations have been much more violent than ever before. * * *

Experience and numerous accurate observations have shown that the temperature of the fermenting room should, as the fermentation goes on, be gradually increased from 15° to at least 22° Reaumur, = 81.5 Fahrenheit, when, besides the decomposition of the sugar, the second and important object in fermentation for wine—that is, the complete separation of all foreign substances, and especially the fermenting matter or lees—is to be effected.

Even during the liveliest stage of fermentation, the yeast matter, oxydized and turned into the fermenting principle, is deposited in so large a quantity that if the liquid is very rich in sugar thoroughly to decompose the same, the yeast matter (lees) towards the end of the fermentation, even at an increased temperature of 22°, must be brought again into greater contact with the fermenting mass by stirring it up by means of the wine-switch, or rolling the casks backward and forward. This effect from an increased temperature in the fermentation, of more thoroughly settling the lees, is made before the whole quantity of sugar is decomposed, furnishes therefore the means of giving the wine any degree of sweetness desired. * * * From a great number of experiments and accurate observations in different regions, it is evident that as the grape requires a certain degree of heat for its ripening, an additional degree, too, is also to be given to the must to make a perfect wine, or one that is not liable to further changes.

If it does not receive this degree of heat during the first fermentation, it has to take up with such a portion of it as there is; but it will be our own fault if, as long as it contains any of the lees matter, it has to undergo repeated fermentations, more or less perceptible, and forming new sediments even when bottled as often as it reaches a higher temperature, than at the end of its first, or its supposed last, after-fermentation. * * * How it happens that under the influence of a higher temperature nearly the whole mass of lees (yeast matter) dissolved in the must can, in a few weeks, possess itself of the oxygen requisite to its oxydation, whilst otherwise it often takes years for it, I cannot say, since hitherto chemistry has been unable to point out the source from which such oxygen is derived. It is a fact, however, that all white wines made to ferment at a temperature gradually increased to 22° Reaumur, and by excluding the atmosphere, deposited double the amount of lees than wine treated in the usual way and grown in the same locality and year; and that having been drawn off from the lees and stored away in cool cellars, they become within three months bright, salable, and capable of being removed from place to place; that is, they attained such a degree of perfection as wines fermented in the usual temperature hardly attain after twelve or fifteen months.

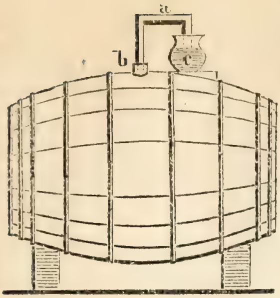
The more necessary it is on the one hand for a much higher degree of temperature than usual during the fermentation to effect a more complete separation of all the nitrogenous compounds, the more indispensable it is on the other hand entirely to exclude the atmosphere from the fermenting must, as otherwise there is increased danger of the formation of acetic acid.

It is believed by many that the carbonic acid gas, a very large quantity of which is formed during the decomposition of the sugar, as it is lighter than the atmospheric air, spreads itself over the surface of the fermenting liquid, and thus furnishes a layer which protects the liquid from coming in contact with the air. This, however, is not altogether correct; for the gases, coming into contact with each other, gradually mix together, a process called the diffusion of gases, and a portion of the carbonic acid gas, though heavier, rises in the empty space, whilst a portion of the common air, though lighter, sinks to the surface of the liquid. It is only with the exclusion of the air that this particular mixing or diffusion of these gases does not take place; if open vessels are used for the fermentation, the mixing takes place; but the more distinctively, the greater the surface of the fermenting mass, the higher the temperature of the place where it is conducted, and the weaker the working at its beginning and end of the fermentation.

It is also believed by many that no *acetic* acid can be formed as long as there remains any sugar undecomposed in the fermenting liquid. This also is a mistake. If the external air has free access, the formation of alcohol first takes place on the surface of the fermenting mass, which is followed by the formation of acetic acid caused by the alcohol coming in contact with the air, and receiving from it its oxygen. This operation is brought about by the lees still present, together with the alcohol in the uppermost layer of the liquid. The lees, after the sugar has been there decomposed, goes on and lends its aid to destroy the alcohol which is hardly formed after such decomposition.

Though this transformation of a portion of the alcohol into acetic acid can scarcely be perceived in white must fermenting in casks, it takes place to a much greater extent in red wines fermenting together with the stalks and skins in open vats. What producer of wine has not observed the swarms of vinegar-flies emerging during warm days, often after twenty-four hours, from the pomace swimming on the surface of the red wines, living witnesses of the process going on between the intervening spaces of this pomace. These vinegar-flies, however, come into existence only after the acetic acid has been already formed.

The must, therefore, should always be made to ferment in vats, so closed as to allow carbonic acid gas formed within it to pass off, while the external air is to be prevented from coming into contact with the fermenting liquid. This object is effected by fitting the



longer part of the fermenting or protecting tube *a*, made of tin, gutta percha, or glass, air-tight, into the perforated bung *b*, and sinking its shorter part a few inches into a glass *c* filled with water. The cask itself must have an empty space of some four inches, and the bung must not project more than a few lines on the inside. The must obtained from red grapes may be made to ferment best in casks set upright, as open vats can hardly be closed air-tight. The same casks may afterwards be used to put the wine on store. After removing the head-board from the casks destined for the reception of the red must, they are set up on a support twelve inches high, with the bung turned towards the front. To draw off the wine from the pomace as required, a tap-hole is made one inch above the bottom, and a tap tightly inserted projecting four inches. The casks thus prepared have now to receive the skins remaining in the vats during the process of pressing the red grapes previously picked. The head is then again set in, and each cask filled through the tap-hole in the top with must, leaving only one-eighth of it empty. After this the seeds, which have sunk to the bottom of the must-vat, should be distributed among the casks, and the fermenting tubes inserted into the tap-holes and made air-tight.

If the must only with the skins and seeds (without the stalks) has been put into the casks, they may safely be left standing until March or April; for after the fermentation is over, the space above the wine is filled with carbonic acid gas, thus protecting it from all injurious changes. Wine of a better quality, in proportion to the degree of ripeness of the grapes, will be obtained by this method, than if drawn off and pressed immediately after fermentation. The head-boards, however, must always be covered with water to prevent the staves of the empty portion of the cask from becoming dry and shrinking, and the joints starting asunder, thus permitting the air to penetrate. The vessel *c* likewise must always be kept supplied with water. To preserve this water, as well as that contained in the head-boards, from becoming foul, a handful of salt or charcoal should be occasionally added.

But if the stalks are also brought into the fermenting tubs, the wine should not remain in contact with them any longer than usual, because they would else impart to it too much tannin. In this case particular care is required for keeping the skins that give to the wine its color immersed in the liquid during the whole period of the fermentation. If they are detached from the stalks, they rise at first to the surface, sinking again after a few days, when their greatest amount of gas has been developed. It is not so, however, when the skins are mixed with the stalks, which, by their greater specific lightness, keep the layer of pomace that forms in the beginning of the fermentation swimming on the surface. Left standing for a longer time these layers would likewise sink. But as they cannot be so left, they must be kept down by means of an additional and perforated bottom, not quite the size of one of the cask bottoms, and which after the pressed grapes have been put into the cask is laid upon them. This bottom is provided with three or four wooden feet or pegs 12 inches long and one inch thick, turned in an upward direction. If now, after the head-board is again put in, the liquid must is gradually poured in, the additional bottom floating on the top of it rises until it is forced to stop by its feet reaching the head-board of the cask, which does not, however, prevent the must from rising still higher, thus always covering the skins and stalks collected below the additional bottom to the height of some four or five inches.

The prevention of the formation of acetic acid, and the possibility thus secured of keeping the wine for months in contact with the skins, are not the only advantages derived from the exclusion of the external air; it is of not less importance that by this exclusion an average loss of wine of six per cent. will be prevented, and that from grapes of equal quality a wine richer in alcohol, and in every respect better, can be manufactured.

As to the diminution of loss being equal to six per cent., we know that in proportion as the air is more or less dry, and to its motion a wet table requires only one-half or two hours to dry again, so that it might become dry 10 or even 50 times within 24 hours.* Now the question is, What has become of this liquid spread on the table? It has evaporated—has been absorbed by the atmosphere. In the same manner a portion of the must coming in contact with the atmosphere disappears, with this difference only, that the diameter being equal, double and three times the amount evaporates from a vat filled with pressed grapes than from the surface of a table; because the really moist surface of the must presented by the layer of pomace of a must-tub to the contact of the air is double and perhaps three times larger than its apparent one. The layer of pomace extending beyond, as it is a very

* In this country still oftener, as the air is much drier than in Europe.—*Translator*

porous mass, its open spaces being penetrated by the air, the visible surface which it presents to the atmosphere is multiplied and increased by the thousand other unseen surfaces in those intervals. But the evaporation from the visible surface is sufficient to explain the loss heretofore stated, and it is the greater as the layer of pomace has to be submerged three or four times a day, and thus drenched by the must to be exposed again and again to the air for absorption.

It is as easy to explain the smaller amount of alcohol of wines fermented in open tubs; for as the alcohol is much more volatile than the water, a much greater quantity proportionally of alcohol disappears in the must that escapes than water.

Besides a portion of the alcohol forming, especially in the pores of the layer of pomace, where there is a higher temperature, is changed into acetic acid, and this explains the inferior quality of wines obtained by open fermentation.

This loss of quantity as well as the deterioration of quality cannot be prevented by merely covering the fermenting tubs with boards or linen, as has been shown by similar experiments instituted in France.

The fermentation being over and the liquid clarified, it will be found that, with the exception of the acids, almost all non-volatile substances of the must have been separated and deposited as sediment, or so-called lees; and further, that the sugar, which had almost totally disappeared, has been replaced by three new substances, œnanthic ether, alcohol, and carbonic acid; the first of which imparts to the wine its peculiar flavor; the second gives the spirituous and lively odor as well as its exhilarating and intoxicating property; the third, of which there is only a small quantity in the wine, gives it the prickling taste.

If a certain quantity of the must is weighed before its fermentation, and its amount of sugar and free acids ascertained, and the total weight of all the other non-volatile ingredients thus accurately determined, on a closer examination of the wine it will be found that it has become lighter by the full weight of the substances separated, and half of the weight of the sugar before present in the must. The grape-sugar consists of 6 atoms of oxygen, 6 of carbon, and 6 of hydrogen. This triple compound is separated by the action of the lees; and of the substances liberated, 2 atoms of oxygen, 4 of carbon, and 6 of hydrogen combine for alcohol, while the other four atoms of oxygen and two of carbon combine as carbonic acid.

It should likewise be remarked that the three substances, oxygen, carbon, and hydrogen, differ in their weights, the hydrogen being the lightest; and hence it is that the carbonic acid, containing only 6 atoms of oxygen and carbon, and formed from a certain quantity of grape-sugar, weighs nearly as much as the alcohol formed of the same amount of sugar, and composed of 12 atoms of oxygen, carbon, and hydrogen. By a more accurate determination 100 pounds of grape-sugar furnish—

Of alcohol	51.9	pounds.
Of carbonic acid	48.2	"
	100	"

ALCOHOL.

The alcohol, or spirit of wine, liberated from water, forms one of the most essential ingredients of all spirituous drinks, from which it may be separated as a combustible liquid, clear like water, very thin and volatile, of a pleasant odor, and a sharp burning taste. It is considerably lighter than water, for, if a cask of distilled water weighs 1,000 pounds, the weight of an equal cask of alcohol amounts only to 791 pounds. In other words, 791 pounds of alcohol occupy the space required by 1,000 pounds of water.

One of its most important properties consists in its weakening and checking fermentation, though it is itself a product of it. The lees of concentrated alcohol are utterly incapable of exciting or sustaining fermentation. It is true that alcohol formed by fermentation, much diluted by the water of the must, has not the same strong power. Still, even in this condition, it has the power to weaken the action of the lees and to retard its operation, and this power increases during the process of fermentation in proportion as its own quantity is increased, whilst the action of the lees is not only weakened in proportion as an increased quantity of alcohol is formed, but also as it gradually loses the heat with which it was combined. When the sugar, at the commencement of the fermentation, is decomposed into its elements, heat is set free, causing the fermenting liquid to become warmer. By this heat the action of the lees is strengthened, the decomposition of the sugar goes on more rapidly, steadily increasing the power of the heat that supports the lees, until, on the other hand, enough alcohol is formed to check the action of the lees, which it does the

more successfully the less new heat is developed, and the more the air of the place of fermentation, and also the fermenting liquid, are cooled down, which is the quicker effected the smaller the mass of the fermenting liquid is, and the greater its surface exposed to this process in the fermenting vessels.

Though the decrease of the heat is at first only the result of the process of fermentation, retarded by the action of the alcohol formed, yet it soon after itself becomes a co-operating cause of a still greater weakness, and finally of a total stoppage. This accounts for the imperfect fermentation of wine and its consequent results in this climate, (Germany,) as well as for the necessity of aiding the lees in the struggle with the alcohol by means of external heat.

Another property of the alcohol is, that, when rarefied, by the lees, it will absorb oxygen from the air and so combine acetic acid. From this reason, and the fact that this process, like all chemical decompositions and combinations, is aided by heat, it becomes necessary to continue this aid only as long as there is any sugar left, and to stop it as soon as all the sugar has been decomposed—a fact which may be known by the carbonic acid being no longer formed.

Strong acids contained in wine gradually decompose the alcohol or combine with it to form different kinds of ether, by which it becomes still more volatile, adding greatly to the odor and flavor of the wine. Such kinds of ether are especially formed in the strong wines rich in alcohol, and add greatly to their peculiar balsamic flavor.

The preparation of alcohol required for good wine is indicated by such standard wines as are produced from the best and ripest grapes of the most favorable localities and seasons. The quantity of sugar contained in must from such grapes will be at least from 22 to 28 per cent.

As we have already allowed to wine from perfectly ripe grapes seven thousandths of acids, the amount of alcohol should be at least 11 per cent.; a rule of Nature herself, which I would the more recommend, as it has been frequently shown by experience that of wines improved by the addition of sugar, the most spirited, the proportion of acids being equal, are not only regarded as the best, but also yield a much higher profit.

It is my firm conviction that at no distant period not only all inferior must will be improved, but that all must, without exception, should always contain from 24 to 28 per cent. of sugar to obtain wines from 12 to 14 per cent. of alcohol.

By Geisler's vaporimeter, the amount of alcohol—say a thimblefull of any liquid—can be determined in 3–4 minutes, with the greatest accuracy, even to 1-10, even 1-20 per cent., (1-1000 to 1-1200.)

CARBONIC ACID.

As we have seen above, a portion of the elements of the sugar, on being set free, and forming new combinations, is changed into carbonic acid during the process of fermentation. At first, this new combination consists of invisible little points in the interior of the fermenting liquid, which are in fact most minute air-bubbles that, by the action of the heat, become more and more expanded, and therefore lighter than an equal space of the surrounding liquid. On account of this increasing lightness, they rise rapidly through the must, impregnated with the alcohol, carrying off a portion of the alcoholic liquid, which is lost when the fermentation is carried on in open tubs, or in casks, with their bung-holes open, being dissolved by the air. Another argument in favor of fermentation in closed vessels.

A portion of the carbonic acid, however, remains dissolved in the wine, and this is what gives to the young wine its prickling taste, and to the sparkling wines their foaming quality. The quality of carbonic acid which can thus be retained depends on the temperature of the wine. The lower the temperature is the greater the quantity.* In the same degree that the wine reaches a higher temperature, another portion of the remaining carbonic again escapes. This accounts for the movement at the beginning of the warmer season in such wines as contain no more of undecomposed sugar, and in which this movement cannot be attributed to a new after fermentation. The carbonic acid, however, gradually altogether disappears. Settled wines, ready for use, do not contain carbonic acid, and such wines only should be bottled, as common bottles are apt to burst, in consequence of the carbonic being expanded by a rise of temperature, or, if they resist the pressure, the wine becomes more or less sparkling, which, though gratifying to the palate in champagne, is not desirable in common wines. The presence of carbonic acid is, therefore, looked upon as a hindrance to their development and perfection, which can mostly be removed by carrying the fermentation in an increased temperature.

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* In sparkling wines, however, after being bottled by means of an artificial after fermentation, a still greater quantity of carbonic acid is developed than they could have retained in open vessels.

The carbonic acid gas, (once called fixed air,) formed by the fermenting must, and diffusing itself where the fermentation is going on, is known by a sub-acid pungent smell. In cellars where there is a great deal of must fermenting at the same time, breathing is rendered difficult by it. A light held over fermenting must is immediately extinguished. If breathed in, the carbonic acid is deadly in its effect. Though this quality is well known in all wine-growing countries by numerous cases of suffocation, yet the same accidents occur every year. The simple precaution of carrying a light before us, that we may know how far to proceed safely, will prevent their recurrence.

All danger may, however, be avoided by pouring lime water (of newly-slackened lime) below and between the casks and tubs, repeating it every three days during the period of the principal fermentation. The carbonic acid and the lime have a great tendency to unite with each other. Now, as the former, in consequence of its weight, sinks at first to the ground, the union takes place, if it finds there any lime, before the carbonic acid gas can enter into combination with atmospheric air.

By the method of fermentation in closed tubs, the danger of suffocation in the fermenting rooms may even be profitably obviated by using the carbonic acid for preparing bicarbonate of soda, the profits from which may reduce the cost for the improvement of the wine.

ETHER.

This substance is a very thin liquid, highly combustible, of an agreeable, pungent, and enlivening flavor, formed in the wine by the action of the acids upon the alcohol. Besides the oenanthic ether or oenanthic acid ether, we find also in wine oxalic ether, formed by the oxydation of a portion of the alcohol and acetic ether, which, however, only takes place when, from neglect, an opportunity is given for the formation of acetic acid. As the production of all ether occurs at the expense of the alcohol, and to an extent unknown, reducing more and more the strength of the wine, we have another reason for giving to the wine, at its origin, at least that amount of alcohol it would have possessed had the grapes used been perfectly ripe.

ACETIC ACID, (VINEGAR.)

This most dangerous enemy of all wines and beverages, like wines, acts the more injuriously since the presence of its smallest quantity, a deserved punishment, for want of cleanliness or negligence, contributes to its own increase. This shows the absurdity of letting the must, with the skins and stalks, ferment in open vessels, and of thrusting into the fermenting liquid the layer of pomace after it has been in contact with the atmosphere and become thoroughly acid. By this means a principal or a vinegar substance, causing the formation of a larger quantity of acetic acid, is actually brought into the wine. It has been contended that the formation of acetic acid takes place only at a temperature over 15° Reaumur, = 65.7 Fahrenheit—an unreliable assertion; for, after acetic acid has once been formed, the wine will become sour, though more gradually so even under 10° Reaumur, = 54.5 Fahrenheit.

The so-called mould covering the wine in casks not kept full is not only a symptom of the wine becoming sour, but is always accompanied by the formation of acetic acid, even though its presence could hardly be detected at the outset.

LEES OR SEDIMENTS IN THE CASK.

As distinguished from the lees-fermenting substance suspended in the liquid during the fermentation and lees in the cask are those sediments which settle to the bottom, partly during the fermentation, and partly while the wine is kept in store. When, in what way, and how often the wine should be drawn off the lees? are questions often asked.

Considering how Nature acts in the production of wine, we cannot for a moment doubt what must be the answer to these questions. Do we not see the must when fermenting in full casks eject the so-called lees, both the real lees, so far as they have done their part in exciting fermentation, and also those ingredients of the juice not belonging to the wine, together with the foreign impurities it contains, thus to purify herself, as the simple vintager aptly expresses it? And, again, is not the same thing also done when the fermentation takes place in casks not wholly filled, with this sole difference, that the substances to be discharged by the must are sent downwards, settling on the bottom of the casks? Many, however, are of the opinion that this deposit of sediment takes place only after the principal fermentation is over. But let the must undergo its fermentation in a transparent bottle not quite filled, the settling of the so-called lees will be seen to proceed as rapidly as when they are thrown out during the fermentation in full casks. After the first two or three days the

sediment already deposited, within the next fourteen days scarcely has added to it one-tenth more—a proof how eager Nature herself is to throw out all foreign matter not fitted to the production of wine.

The so-called lees, the presence of which in wine casks is said by some to better the quality of the wine, consists of a very little real lees which have, indeed, fulfilled their object of exciting fermentation, then of a large portion of mucilage, a substance which, of late, many have tried to remove prior to the fermentation, and, finally, of a quantity of dirt of all sorts, which has come mixed with the must from without, such as crushed snails and insects, eggs of insects, excrement of birds, sweat and dirt from the laborers, earth, sand, &c.

Since the greater part of the lees, as already mentioned, notwithstanding the fermenting movement, settle during the first days, so the first drawing off should take place directly after the principal fermentation; and, as the settled lees can have only an injurious effect on the alcohol when found in contact with it for a longer time, they should be separated from the wines as often as any considerable sediment has been formed, or, as we cannot always perfectly judge of this fact, at least three or four times previous to the commencement of the warmer season.

PREPARATIONS FOR THE VINTAGE.—CLEANING THE UTENSILS USED IN THE VINTAGE.

The must never leaves the press in a better but often in a much worse state than its natural one, even in the most unfavorable seasons. This, however, is the fault of man himself, for the carelessness with which the utensils of the press, and especially the press itself, are cleansed is almost incredible.

It is thought sufficient to rinse them merely with water, while the tubs for receiving the grapes and must, and which can, when done with, be put into a brook or stream near by, are watered for weeks, showing that a mere washing away of the dirt on the surface is not deemed enough in the case of these wooden utensils. Some twenty years ago it was found, in a distillery of Prussia, managed on scientific principles, that, other things being equal, a perfect cleanliness of all the wooden utensils used in connexion with the mash made a gain of from 10 to 15 per cent. more of alcohol. This fact was shortly after scientifically explained, it being shown that the fluid mash remaining in the pores of the wood is by means of the alcohol there changed into acetic acid, and that this acid, the worst foe to every spirituous beverage, lessens the gain of alcohol in two ways: first, by disturbing its formation; secondly, by causing acetous fermentation after the alcohol has been formed, converting a portion of it into acetic acid. No improvement has since attracted a greater share of attention in the distilleries than the reduction of this acid, which is so hostile to alcohol. In those distilleries that are best arranged, the inside of the fermenting vats are carefully varnished, and the tubs for the yeast and the cooling vessels are even lined with copper. Such other wooden utensils as cannot be protected in this way from the mash penetrating into their pores and joints are cleansed with the most scrupulous attention.

In making wine, however, the same cleanliness with respect to all utensils is still more indispensable. By giving them a mere washing or rinsing they will only be cleansed on their surface, their pores and joints remaining filled with acetous fermentative substances. Acetous acid in the fresh wine, as in must, not only hinders the formation of alcohol, but produces the acetous fermentation—that is, the gradual change of alcohol into acetic acid, and thus causes the wine to become flat and to turn sour; it is, therefore, considered as one of the principal causes of many distempers of wine. Another injurious effect of acetic acid is its preventing the formation of the ether of oenanthic acid, to which wine made of grapes owes the peculiar balsamic vinous odor that distinguishes it from every other sort of beverage.

The most perfect cleanliness of all the utensils used is therefore a principal and indispensable condition in the manufacture of wine. All wooden implements, especially the press, should be washed and scoured with lye or lime water and a brush of stiff bristles, until, after repeated rinsings, a piece of blue litmus paper brought in contact with any moist spot of the article washed no longer turns red.

The same care must be given to the cleansing of the casks, so as to avoid the repugnant tang in them, which prevails so generally and to such a degree that, in some parts of the country, a quarter of all the wine produced is affected by this unpleasant taste, while in others the native wine-drinkers have become so much accustomed to it as not to notice it, unless it is very strong.

As to *new* casks, the tan is quickly and easily removed by the application of lime. Twenty pounds or so of unslacked lime is required to a hogshead (FUDER.) It is crushed into small pieces and put into the cask through the bung-hole, and then about an equal amount of

warm water is poured over it. After the lime has fallen apart, two quarts of boiling water are added to each pound of lime, the bung is put in tight, and the cask turned about every hour in all directions, and then lies for one hour, sometimes on one side and sometimes on the other, or it is left standing alternately on either its bottom or head. After pouring out the lime water, the cask is twice or so washed with warm water, and then rinsed with a decoction of vine leaves, or with warm cloudy wine (Trübwein.) Finally, it is rinsed once more with cold water.

A better method is to steam the cask, or, still better, the wood of which they are made. For this purpose the best apparatus are portable generators of steam, which can be set up in the open air. They are also well fitted for steaming the large casks kept in the cellar, (Lagerfässer,) as they can be set up near each cask. See my book "Description of my portable Generators of Steam," Trier, 1844, (Beschreibung meiner tragbaren Dampferzeuger.) From the description there given they can be built of the required size or power by any coppersmith, and much cheaper than a common steam kettle and its mason work would cost. This unusually useful article may serve for many other purposes in agriculture, such as for steaming fodder, for milk vessels, for use in distilleries, and for washing by steam, melting grease, boiling dead animals, &c.

After the tan has been removed from new casks destined for receiving *red* wine, they may be rinsed with a warm decoction of peach leaves, and turned about.

Old casks affected by the tang, though yet free from any mould, are at first likewise treated with lime and water ; after this they are washed with a decoction of walnut leaves and juniper berries, in which kitchen salt, (two pounds,) and alum (one-half pound to the hogshead,) have been dissolved ; and lastly, they are rinsed with cold water.

Mouldy casks must be opened and the mould scraped off or burned out with a red-hot iron, after which they are to be treated as above.

If the tang or mouldy smell should not wholly give way to these means, there is another and still more effectual remedy left in the application of bran. Some 60 pounds of it to a hogshead are put into a cask and left to ferment. Water of 65° R. = 178.2 Fahr. (one quart to a pound) is first poured on the bran. An hour afterwards, three times in succession, as much more cold water is added, together with the fourth part of a quart of yeast mixed with a quart of lukewarm water, for every 20 pounds of bran. The bung-hole is then closed and the cask rolled about for some minutes, after which the bung is somewhat loosened. During the fermentation about to commence and to continue for two or three days, the cask is placed half the day first on one side and then on the other. After eight days the bran paste, which may now be used as fodder, is poured out, the cask is rinsed with water, and cleansed again with lime until litmus paper applied to it ceases to turn red.

The above remedies, effectual as they may be, are not always sufficient to give the wooden vessels a thorough cleaning, especially in cases where mould has begun to form. Mould occurs much more frequently than is noticed, many kinds of it being composed of so very minute plants that in the first stages of their growth they cannot be seen by the naked eye. This tiny vegetation consequently finds plenty of room in the pores of the wood for its development, and though it may be easily removed *from the surface*, it is difficult to reach it in these little holes. But hidden, as it is, in the pores, the mould cannot resist the destructive action of sulphuric acid, if time enough is allowed for it to penetrate into the pores.

The sulphuric acid used for this purpose must be more or less diluted, according as the mould is white or yellow. For the latter, one pound of acid requires five pounds of water, but in the former case one pound of acid needs only two pounds of water. In mixing these two fluids the acids should be very slowly poured in the water, forming a very thin jet, otherwise the mixture may spurt up, endangering the operator or the by-standers. After cleaning the vessels with water and a brush, they are gone over with this mixture at all such places as indicate any mould, and the vessels are then so laid down as to give the mouldy spot a horizontal position. In this position it is again wet with the diluted acid, allowing about an hour for it to penetrate into the pores. Another mouldy spot is next brought into the same position and treated in the same way. This method is continued until the whole vessel is properly soaked with sulphuric acid. After a lapse of some 24 hours the vessel is rinsed with clean boiling water, scoured with strong lye, and, lastly, rinsed again with water.

Finally, all casks which needed so thorough a cleaning must, of course, again be made wine-seasoned, (Weingrün,) and if they are not to be immediately used, they must be smoked or charred.

In casks destined for *red* wine this is done by means of a nutmeg cut in two halves and lighted ; it will burn like a candle, fills the casks with an aromatic odor, and produces the same effect, but without changing the color of the wine, as where sulphur is used.* Two nutmegs are sufficient for a hogshead, (Fuderfass.) The nut, which by means of the burn-

* This effect of the use of sulphur is, however, but transient, the original color returning in a short time.

ing hook is held in the middle of the cask, must be taken out again before it begins to smoke, as it would otherwise leave a bad smell in it.

The casks destined for *white* wine are usually burnt out with arsenious, or so-called cask or cooper's sulphur, (Fass-schefel. Schwefelspan.) Though the quantity of arsenic contained in this kind of sulphur is too small directly to poison, yet it is generally known that its use, especially in the case of wine on the tap, will produce headache and frequently sickness.

Instead of this arsenious sulphur, I recommend the use of another kind of cask or cooper's sulphur, perfectly free from arsenic, manufactured by Mr. J. Fs. Bürkle, of Grossheppach, district of Waiblingen, Wirtemberg, and also recommended by the public officers of almost all the German States. In the Industrial Exhibition held at Mayence in 1842, Mr. Bürkle received a prize medal for this article, which was likewise recommended by the Industrial Association of that city. They caused a chemical analysis to be made of it by Dr. Winkler, of Zwingenberg, and spoke of it in the following terms:

"The sulphur slices for wine, or the so-called cask or cooper's sulphur of Mr. Bürkle, to which aromatics are added, are chemically perfectly free from all injurious substances contained in the raw sulphur. As the dealers in wine and hotel-keepers are not always able to ascertain the perfect purity of the sulphur slices, it is certainly a matter of great importance to be supplied with a pure article, from the use of which there can be no danger. It is well adapted to burn out casks constantly used, and those not quite filled up and kept in store for a longer time, as well as such as are destined for the keeping both of inferior and superior wines. The chemical analysis has shown that this sulphur contains not a particle of arsenic whatever, and that the spices added to it principally consist of cloves."

To prevent any coal from remaining in the casks when they are burned out, either by sulphur or nutmeg, it is advisable to use a small cup of plate iron, (instead of the usual burning-hook,) to which are fastened three wires meeting at the top, and ending in an ear. This contrivance is connected with a hook fastened at the bottom of the bung by means of this ear. The burning material (sulphur or nutmeg) is then lighted and put in the cup, after which it is let down into the cask. In order to admit the air to it the cup is provided with a few small holes.

A FEW NECESSARY IMPLEMENTS.

For dissolving the grape-sugar to be added to the must, and for boiling the water needed for diluting the acid, one must have either a pan *(Chaudière à bascule)* like those used in the manufacture of sugar, or a steam apparatus, because, in boiling the sugar in common kettles, it would be difficult to avoid, on emptying the sugar, more or less harmful burning, or at least overheating of the thick solution from the heated sides of the kettle.

This pan is a circular vessel, made of copper or iron plate, from 40 to 60 inches in diameter, with a side from 8 to 10 inches high; it is flat-bottomed, and has an outlet in front. It is set on its hearth in such a way as to expose the bottom only to the fire. In order to empty it at once, on the edge of the pan opposite the outlet, a rope is fixed moving in a pulley. By this the pan is raised, turning around on an axis, which holds it fast to the brick-work in front.

A more useful plan, however, is a steam apparatus, consisting of a small steam kettle, or, better, of a portable steam generator, and one or two wooden vessels used in cooking, because, even in the pan described above, we can only avoid burning the solution by the greatest care, while in the use of steam there is no danger even of its overheating. If a common wash-kettle set in mason-work must be used, hang a basket containing the sugar in it, and let the sugar melt in the water.

To dispense with measuring the water whenever an addition to the must is required, a gauging rod should be prepared for the pan or boiling vessel or kettle, marking the contents of these vessels by two to three Prussian quarts, (about one-half or three-quarters English,) which serve as a measuring unit for the basis of our calculations.

For crushing the solid and somewhat tough variety of grape-sugar a strong, flat tub, three feet in diameter and eight to ten inches in height, is needed. As the sugar-casks, weighing from 1–5 cwt., are to be put in these tubs, and the lumps of sugar, after the removal of the covering boards, are to be crushed in them, they ought to be provided with a strong bottom well bolted, so as to resist the weight and blows.

Further requisites are, a pair of scales, or, better, a decimal balance; some tin buckets, with an outlet; a few baskets, with two handles for receiving the sugar to be weighed—these must be numbered beforehand, and both the numbers and tare written on a wooden label attached; a broad hatchet and a wooden mallet or beater for pulverizing the sugar; a skimmer, a tin scoop, a pair of stout portable stairs, with five or six steps, that can be attached to the casks for carrying away the hot solutions of sugar, and a wine-whip or rod for mixing the solution with the must. This wine-whip or rod is a round stick four feet long and one and a quarter inch thick, split from the lower end to the middle into four parts,

somewhat diverging, and which can yet be slightly compressed when the rod is put into the cask. It must also be well rounded so as not to injure the circular bung-hole, otherwise the bung cannot keep the cask tight.

For heating the fermenting room the so-called filling furnaces (Füllöfen) are particularly adapted, because the temperature can be best regulated by them, and they can be provided with fuel for ten to fifteen hours, and need no watching during the night.*

CONDENSED RULES FOR THE GATHERING OF GRAPES, AS LAID DOWN BY GALL, AND ADOPTED BY THE MOST SUCCESSFUL WINE-GROWERS OF GERMANY.

1. If possible, the grapes should be gathered only when they are richest in sugar and weakest in acids. This is the case for *soft* grapes when they are perfectly ripe, while for hardier ones it is so when the ripest of them show signs of rotting.

2. As the grapes will not all ripen at the same time as those which first ripen first begin to rot, we should try, by gathering them two or three times, to obtain those that first ripen in their best possible state, and to lose as few as possible by their rotting.

3. In case, however, this mode of gathering cannot be adopted, it is advisable to gather first when the general vintage begins, all that are perfectly ripe, and the rest afterward. Or let the gatherers be arranged in two parties, one going before the other, and collecting only the ripest and healthiest grapes, the other following and collecting the rest. Children may follow the second party, to pick up such berries as have fallen to the ground.

4. The previous gathering (the first, second, or third before the general vintage begins) should, if possible, be only on warm, dry days, after the grapes have been warmed by the sun, and dry from dew or rain. If it rains the gathering should be stopped.

5. Choose the most intelligent and skilful laborers for gathering.

6. Provide the gatherers with strong, sharp scissors, as by breaking or cutting off the grapes with knives the vine will be shaken, causing many of the best berries to drop off.

7. Allow no grapes to be eaten either in the press-house or in the vineyard, under the penalty of dismissal; but the better to enforce this rule pay the gatherers double wages.

8. Use small baskets only, especially in gathering the ripest grapes, so as not to crush them by their own weight. Generally use only water-tight vessels, baskets lined with pitch, or small wooden hand-tubs, so as not to waste or lose any juice.

9. In the general vintage charge each person to collect the grapes left by the party before him, and provide him with two vessels for gathering, one for those grapes not perfectly ripe, though healthy, the other for all the rest—the rotten, the burst, the hail-struck ones, &c.

10. Leave the grapes which are affected by dry rot on the vines.

11. At the bottom of the vineyard, if the weather will admit, or in the press-house, or some other spacious locality, put up a few tables on which to spread the grapes previously collected, and to separate all not perfectly ripe from the good. The high prices paid for wine made from perfectly ripe and carefully-selected grapes will certainly prove an inducement to select again the *best berries* from the *ripest*, for such wines only can be manufactured by artificial aid as are produced from the best berries of the most excellent grapes.

THE LABORS IN THE PRESS-HOUSE.—RULES FOR MAKING MUST.

1. Let the berries of such grapes as are destined for the manufacture of red wine, and which are not subject to sweating, always be picked from their stalks, whether or not the stalks have ripened; for if they have so, they absorb must; and if unripe, they will, during the process of pressing, add to the must still more acid, of which it already has an abundance. The tannin contained in the seeds, which go into the fermenting casks, is enough for the wine, if the process of fermentation be conducted in the manner heretofore indicated.

2. Allow all the ripest grapes secured by gathering once or several times previous to the general vintage, and in an uncrushed state, especially those richest in aroma, some days to ripen yet more thoroughly, and to ferment without their berries being picked off. For this purpose provide vats or tubs with a perforated inside bottom six inches above the proper one. Close below and at equal distances let there be from four to six air-holes, with bungs or stoppers. This tub having been filled with grapes, which must be carefully put in separately, cover it over and leave the grapes for a few days to their own heat. This self-heating having begun, after three or four days open the air-holes and remove the cover, but after an hour's time close the holes again and restore the cover. Repeat this operation daily three

* Plain filling furnaces cost from 7 to 12 Prussian thalers, (about $5 50 to $9 50) and may be had from Peter Heil, of Treves; of Mr. Leeb, of Eisenstadt, Austria, and of Mr. Steindörfer, of Vienna.

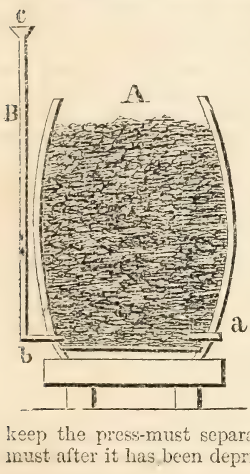
or four times for as many days. The result of this self-heating is an after ripening of the berries by which another portion of their acid is turned into sugar. Besides, the heat expands the juice in the berries, and forces a portion of their water through the pores—they *sweat*. Hence, after two or three days the grapes are found quite moist. Open the air-holes and remove the cover, thus inducing a current of air through the open spaces between the grapes, which is the more brisk the higher the temperature is, and thus the more quickly absorbing their moisture the more dry it is. After sweating for several days, during which the berries with the thinnest skins burst open, let the grapes be mashed as thoroughly as possible, and allow the mass together with the skins to ferment for a few days longer in order to receive a portion of the aroma contained in the skins. Then begin the usual operation of pressing, let the red grapes without stalks be brought into the fermenting tubs, and the white under the press.

3. Watch the operation of pressing the choice grapes with the acetometer in hand so as not to add any more of the product of the second pressing to the unpressed wine, *i. e.*, wine-juice running out without pressing, or to that of the first pressing, than is required to obtain must of 6, at most 7½, thousandths of acid for making an excellent select wine—bouquet wine of the first quality, &c. The tannin required is given to it by throwing into the fermenting tubs a portion of the seeds settling in the tubs or baskets used for gathering the grapes.

4. Put the remainder of the must of both the second and the last pressing into separate casks to mix it with the unpressed wine of the *general* vintage, so as to make a wine of the second or third quality, with or without addition of sugar and water according to the season.

5. In the *general* vintage let the press-must again be kept separate from the must of defective and rotten grapes.

6. Use the pressed skins of the *previous* vintage and those of the *sound* grapes of the *general* vintage for making wine from pressed skins, *i. e.*, wine from skins or after wine. To prepare this wine with more leisure, let the remains of the grapes (the skins or husks of pressed grapes) be immediately removed from the press into a cask, open at the top A and stamped in. Close to the bottom is an opening made for the insertion of the leaden tube B, one inch wide, and provided below with the knee piece *b*, and with a funnel above *c*. Opposite to this opening, near *b*, is the tap-hole *a*, with a stopper. After the cask has been filled with the skins of the pressed grapes, let cold water be continually poured into the funnel until it makes its appearance at their surface A. The object of this is to remove the air in the intervening spaces of the skins, which is done by the water rising from below, expelling the air and taking its place. But for this the oxygen of the air in these spaces would combine with the alcohol of the skins of the pressed grapes, and form acetic acid; and were they allowed to stand for a longer time, the nitrogen, the other constituent of the air, contained in these intervening spaces would cause decomposition of the surrounding particles of the skins. But if the spaces are thus filled up with water from below, the skins may be preserved for months without incurring any risk.



7. Mix the unpressed wine (Vorlauf) of the rotten and defective grapes with the must obtained from sound ones; but keep the press-must separate to subject it to fermentation, together with the mucilaginous must after it has been deprived of its mucilaginous matter.

DEPRIVING THE MUST OF ITS MUCILAGINOUS MATTER.

The mucilaginous particles, together with the cellular tissue, are undoubtedly the only unripe and unfinished ingredients of the grape-juice, those which, in the process of vegetation, are stored up in the berries, and from which, during their ripening, acids and sugar are formed. Grapes of the same varieties, therefore, contain the more mucus the less ripe they are. Numerous experiments for the removal of mucus and fermentation, made in transparent and graduated bottles, show a sediment of from 8 to 15 per cent. What is the use of this crude substance which both the must during its fermentation, and the wine kept in stores labors to eject, and which, in order to have a salable wine in a short time, we must remove, by the use of substances foreign to it, such as sulphurous acid, (formed during the fumigation with sulphur,) tannin, bladder of the sturgeon, and other means of clarification. It should, therefore, be removed before fermentation takes place, as has been done in manufacturing sparkling wines ever since the first bottle of champagne has been made. In the North of France, where the grapes seldom attain to a perfect ripeness among the great proprietors, the removal of the mucus has already come into general use, and it has

also in Styria, where the first experiment of the kind was made in 1831, and ever since this improved mode of making wine has been generally introduced. The mucus should be removed from must of grapes not perfectly ripe, in order to procure wines of a better and finer quality; secondly, from wines that can be sold earlier; and thirdly, from those wines as without having been fermented in a higher temperature, will undergo no other fermentation at a later time, because most of the lees (yeast substance) in excess has also been carried off with the mucilaginous matter.

The method for the removal of the mucilaginous matter is the following:

Let a cask thoroughly burnt out with sulphur, free from arsenic, be one-third filled up with must fresh from the press and rolled about for a few minutes, so that the must will better receive the sulphurous vapors. After this, burn another sulphur slice in the cask, fill it up two-thirds with must, and roll it about. Finally, give it another fumigation of sulphur, and then fill it up quite full, roll it about again, and leave it quiet. The higher the temperature the more sulphur must be used. After 36 or 48 hours' time all impurities will have settled, and then let the must, which stands clear as water above the sediment, be drawn into a clean cask which has not been fumigated. Let the sediment be mixed with the press-must of the rotten grapes and allowed to undergo a separate fermentation. After this is over, there will not be the least sign of sulphurous vapors left in the wine.

PRACTICAL INSTRUCTIONS FOR THE BETTERING OF MUST.

Every kind of wine prepared from must which contains more than seven thousandths of acids will be better in proportion as its quantity of acid and sugar, by a proper addition of sugar and water is rendered equal to the quantity of acid (6½ thousandths) and of sugar (28 per cent.) in the must from the best grapes of the most favorable seasons.

Thus I would propose to reduce a Riesling must of 28 per cent. of sugar, were it to contain more than 6½ thousandths of acid (as indeed it does not) to this maximum quantity in the best must.

By the proposition that every wine will be as much better the nearer its must can be brought to 6½ thousandths of acid and 28 per cent. of sugar, it is by no means asserted that the composition of every must is, of course, to be strictly kept within these limits. Wines of different qualities and prices being demanded for commerce, I would rather recommend—

(*a.*) That only the must of the Riesling, Traminer, Ruländer, Muscatel, and *Black* Burgundy, (or must of hard grapes,) should have 6½ thousandths of acid, and from 26 to 28 per cent. of sugar.

(*b.*) That must of soft grapes and of from 6½ to 7 thousandths of acid receive but from 20 to 22 per cent. of sugar.

(*c.*) That in must of mixed grapes (soft and hard) this quantity (20–22) may be increased to 25 per cent.

Having been requested to lay down for those who are without a must-scale and acetometer approximate proportions for the addition of water and sugar, I recommend—

(*a.*) Thirty-five quarts of water and 32 pounds of sugar to 100 quarts of must, where there has been no previous gathering.

(*b.*) Fifty quarts of water and 50 pounds of sugar to 100 quarts of must, in case the best grapes have been already selected.

In all circumstances, however, a little less acid than 6½ thousandths is better than a little over 7 thousandths, and a little more than 24 per cent. better than a little less than 20 per cent. of sugar. But it is far better to make use of the admirable instruments for measuring proportions, which can now be obtained.

At the outset of the work of improving our must we should see that the press-apparatus, as well as the casks receiving it, together with the skins of the pressed grapes, are all perfectly clean. The casks should then be marked with the letters A B C, &c., and the number of quarts every cask contains be set down below the letters, respectively. A book or journal should also be kept for entering the necessary remarks, giving a page to each cask. We should further provide ourselves with the requisite fermenting tubs, with perforated bungs, and see that the bung-holes are well rounded and closed air-tight by the bungs, taking care that these, when they are in, do not project into the casks. At some well-lighted place in the press-house or fermenting room there should be a table large enough for conveniently examining the must and making the necessary calculation, as well as to hold ready for use, all the other utensils requisite, such as those for the removal of the mucilaginous matter, a few bottles, some tin funnels, linen cloths (rags) for filtering the must, cask-sulphur, fermenting tubs, water baskets, the instruments for ascertaining the quantity of sugar and acid, soda, writing materials, &c.

It matters not, as respects success, whether we proceed *immediately* to the bettering of the must deprived of its mucus, by mixing it with the necessary solution of sugar, or do it

during or some eight or fourteen days *after* the first fermentation. We may, therefore, delay this operation if other work is more pressing at the time. A longer season also can thus be gained for procuring the grape-sugar, which, as its manufacture is resumed only after the potato crop has been gathered, cannot always be had in sufficient quantity before the vintage. Such a delay, until after the usual works of the vintage are over, may, likewise, enable us to devote more leisure to making the necessary arrangements, as well as to the calculations for determining the quantity of the solutions of sugar to be added to the must.

The examination, however, as to the quantity of sugar and acid contained in the must is absolutely required to take place previous to any signs of fermentation, and in warm weather even before the removal of the mucus begins; for, as the sugar is decomposed by fermentation into alcohol, (which remains in the must, and into carbonic acid, mostly escaping as a gas, though partly retained by the must,) it gradually disappears; and as, on the other hand, part of the solution of ammonia necessary for ascertaining the quantity of acid is neutralized by that part of the carbonic acid retained in the must, it is evident that an examination made after fermentation has begun will show not only a smaller quantity of sugar, but also a larger quantity of acid than the must originally contained.

If, however, in very warm weather the fermentation has already commenced before the cask has been filled up, in determining its quantity of sugar the weight of the must is to be set down one degree higher than is indicated by the must-scale. To ascertain the quantity of acid, heat one-eighth of a quart of must to the boiling point in a tin vessel over a spirit-lamp, and thus set free the carbonic acid. Let this must then be cooled down again to 14° Reaumur, = 63.5 Fahrenheit, as fast as possible in cold water, before the examination takes place.

After filling a cask with must, and ascertaining its acid and sugar, the results may thus be entered upon the journal:

Vol. 1, Let. A: A hogshead of 860 quarts, filled 4, 9 A. M., with 840 quarts of must of, [here insert the names of the grapes and of the place of their growth.]

Quantity of sugar, 16.2 per cent.

Quantity of acid, 9.2 thousandths.

Vol. 2, Let. B: A hogshead of 872 quarts, filled the 4th of November, 11 o'clock A. M., with 852 quarts of must deprived of its mucilaginous matter, and made of mixed grapes of, [insert the names both of the grapes and of the place of their growth.]

Quantity of sugar, 15.6 per cent.

Quantity of acid, 9.5 thousandths.

Vol. 3, Let. C: One cask of 950 quarts, filled 5th November, 10 o'clock, A. M., with 930 quarts of must deprived of its mucilaginous matter, and made of, [names of place and locality.]

Quantity of sugar, 15 per cent.

Quantity of acid, 9 thousandths.

An excellent Riesling must contains at least 24 per cent. of sugar, (by weight,) and at most $6\frac{1}{2}$ thousandths of acid; 1,000 pounds of such must contain, therefore of:

	Sugar.	Acid.	Water and different component parts.
	240 pounds	6.5 pounds.	753.5 pounds.
Our supposed must A is presumed to contain	162 "	9.2 "	828.8 "
Must A therefore contains:			
Too little	78 "		
Too much		2.7 pounds.	75.3 pounds.

Though this deficiency of sugar might be supplied, our must A would, nevertheless, still contain almost one-half more of acid and one-tenth more of water than is present in a standard must, and, notwithstanding the addition of water, would make a very sour wine. Unable to remove this surplus of acid and water, the question arises How we can remedy it? The cure will be suggested by reverting to the case of mixed beverages principally composed of water; for instance, punch, lemonade, &c. We here add such an illustration. To make one quart of good lemonade would require:

	Water.	Sugar.	Lemons.
But if we make it of	$\frac{6}{8}$ quart. $\frac{7}{8}$ "	12 ounces. 8 "	2 pieces. 3 "
The lemonade will be sour, *one quart* containing:			
Too much	$\frac{1}{8}$ "	----------	1 piece.
Too little	----------	4 ounces.	----------

We discover, however, that our lemonade, in proportion to the lemon juice added, is not only *deficient* in sugar, but also in *water;* in other words, the *three lemons* would have been sufficient for preparing a *larger quantity of lemonade.* We now take a larger vessel for pouring in the lemonade, and, in order to render it good at once, make a calculation for the addition of sugar and water required. As the standard lemonade had the proportion of $\frac{6}{8}$ quart of water and 12 ounces sugar to 2 lemons, three lemons require $1\frac{1}{8}$ quart of water and 18 ounces of sugar, instead of which we had for three lemons, $\frac{7}{8}$ *quart of water and* 8 *ounces of sugar.* Our lemonade therefore lacked $\frac{2}{8}$ quart of water and 10 ounces of sugar.

The same rule applies to the improvement of sour must.

As regards our Riesling must, Let. A, it is at once seen, by the comparison of its principal component parts with those of the standard Riesling must, that the former (Let. A) contains acid enough for producing a much larger quantity of must.

Now, if 6.5 pounds of acid require 240 pounds of sugar to make that Riesling standard must, 9.2 pounds of acid, contained in Let. A, require 339.69 pounds, or, in round numbers, 340 pounds of sugar.

Further, if 6.5 pounds of acid require 753.5 pounds of water (including the indifferent parts) for Riesling standard must, then 9.2 pounds of acid in Let. A will require 1066.5 pounds of water, (or $6.5 : 753.5 = 9.2 : \times$ 1066.5 parts.)

	Sugar.	Acids.	Water, &c.
As the must Let. A, which should contain	340	9.2	1066.5
Contains already	162	9.2	828.8
The addition required is	178	--------	237.7

The improved must will therefore consist of—

	Pounds.
Sugar	340.0
Acids	9.2
Water	1066.5
Total	1415.7

Still more practical is the following method, which we will apply to the calculation necessary for improving the must Let. B. In using this method we remember—

1. That our calculations are based on the Prussian quart and the tariff pound, (customs-union pound = $\frac{1}{2}$ kilogramme) (a little over $\frac{1}{10}$ English pound) as the units for liquids and weights.

2. That we take one quart of water to be equal to 2.3 pounds.

3. That the following proportions of the different kinds of sugar when dissolved in must or water will occupy the space of one quart, viz:

3.7 pounds of sugar free of water.
3.6 pounds of cane or beet-root sugar, (loaf sugar, lump sugar.)
3.6 pounds of dry grape-sugar.
3.5 pounds of solid grape-sugar of a dry feel.
3.4 pounds of solid grape-sugar slightly moist.
3.3 pounds of syrup of 39 to 40 degrees.
3.2 pounds of syrup of 37 to 38 degrees.

The weight of the must, in proportion to its quantity of sugar, is given in the table for the must scale.

Proceeding to make our calculations for must, Let. B, containing 15.6 per cent. of sugar and 9.5 thousandths of acid, we have to ascertain the addition of sugar and water required to each 100 quarts. As this must contains 15.6 per cent. of sugar we know by the table that 100 quarts of must of this quality weigh 243 pounds. The quantity of acids contained in them is (243 × 9.5 =) 2,308.5 (2,308½) thousandths. As this must, after its improvement, still contains 7 thousandths of acids, the 2,308.5 thousandths of acids contained in 243 pounds, or 100 quarts, of *crude* must will be sufficient to produce $\left(\frac{2,308.5}{7} =\right)$ 329.8 pounds = 135.7 quarts of improved must of 7 thousandths.

Every 100 quarts of crude must require, therefore, an addition of the solution of sugar of 35.6 quarts.

The sugar contained in 100 quarts = 243 pounds of crude must, at 15.6 per cent., amounts to (243 × 15.6 =) 37.9 pounds.

After adding the solution of sugar the must thus improved, and amounting to 135.7 quarts, will contain 20 per cent. of sugar, according to the must-scale, which shows 100 quarts of 20 per cent. of sugar; this must will weigh 335.1 pounds, and consequently contain (335.1 × 20 =) 67.0 of sugar.

Every 100 quarts of crude must require, therefore, 29.1 pounds.

Now, in using *solid* grape-sugar of but 80 per cent. of sugar we require, as an equivalent of the above, 29.1 pounds, (80 : 100 = 29.1 : x =) 36.3 pounds, which occupy, in the 35.7 quarts of solution of sugar to be added to the must, a space of $\left(\frac{36.3}{3.4} =\right)$ 10.7 quarts.

It requires, therefore, 25 quarts of water for preparing the solution of sugar.

From the foregoing calculations it appears that every 100 quarts of *crude* must, Let. B, require an addition of—

25	quarts of water, and
10.7	quarts of solid grape-sugar, (36.3 pounds.)
135.7	quarts.

One hundred quarts of *crude* must will, therefore, be increased to 135.7 of *improved* must, requiring a space for its rise of about 4 per cent., being 5.3. One hundred quarts of crude must will thus require a cask holding 141 quarts.

In the cask, Let. B, holding 872 quarts, 620 quarts can be improved (140 : 100 = 872 : x =) leaving 252 quarts of empty space for the solution of sugar and rise. But as it already contains an empty space of 20 quarts it requires only an additional space of 232 quarts, leaving 620 quarts of *crude* must in the cask of (872) for improvement.

These 620 quarts of crude must should, therefore, receive, in round figures:

a Of *solid grape-sugar* of 80 per cent. 36.3 pounds for every 100 quarts, making, therefore, for 620 quarts, (620 × 36.3 =) 226 pounds, occupying a space of $\left(\frac{226}{3.4} =\right)$ 66 quarts.

b Of *water* (6.20 × 26 =)	155	"
This, in addition to the 620 quarts	(620)	"
will make of improved must	841	"
which, subtracted from the capacity of the cask	872	"
leaves a space for the rise of	31	"

In order to avoid confusion the result of these calculations should immediately be entered on the journal, cask Let B, perhaps, thus:

1. The quantity of sugar to be increased to 20 per cent. and the acid to be reduced to 7 thousandths.
2. Therefore 232 quarts of must are to be taken out of the cask.
3. In the place of which there are to be added 221 quarts of the solution of sugar.
4. To prepare the solution of sugar requires 155 quarts of water and 226 pounds of solid grape-sugar of 80 per cent. of sugar.

METHOD OF PREPARING THE SOLUTION OF SUGAR.

The grape-sugar of commerce is found in a solid, slightly moist form. In the refineries it is poured while yet a warm fluid into the casks, in which it consolidates into a compact mass of the size and form of the cask itself. To remove the sugar from the casks they are placed upright in the crushing tubs for the purpose of beating off the hoops and removing the staves. Then the lump of sugar is laid on one side for cutting it into pieces of from five to ten pounds. As this operation is somewhat troublesome and requires much time, another tub should be in readiness to receive the sugar already crushed. It is, however,

easiest done by placing the edge of an axe or a hatchet on the lumps and giving it a few violent blows with a wooden mallet. There is no necessity of removing the packing straw adhering to the sugar, for it will rise to the surface as the sugar melts, when it can be easily taken off.

In case wash-kettles are used for dissolving the sugar (though we cannot recommend them) the utmost care should be taken to prevent an overheating of the solution of sugar, to which they are exposed in deep kettles, whenever we stop stirring it even for a short time. The simplest means of preventing such an exposure is to give a basket of skinned willow twigs a thorough boiling in water, and suspend it in a kettle filled with water so that neither the bottoms nor the sides touch each other, and to keep the fire no longer than is required for melting the sugar in the basket without allowing the liquid to boil. To accelerate the process of melting and to shorten the period of heating, the fluid must be continually stirred. After the sugar has been completely dissolved and the basket removed, the fire must be extinguished by ashes; the stove door is now kept open and the kettle allowed half an hour to cool off before scooping or drawing off the solution.

Let the kettle, whether of iron or copper, each time before used, be scoured with a soft brick and thoroughly washed out.

In using a steam apparatus add only three-fifths of the water required according to the calculations in the boiling vessels, as during the progress of melting it will be increased about one-fourth or one-third from the vapor condensing into water.

After the melting of the sugar measure the fluid again by the gauge for to determine the quantity of water that may still be wanted. But as the solution seething hot, as it is, and expanded by the heat, occupies a space about four per cent. larger than it would at the usual temperature of well-water, this difference also is to be provided for by adding four quarts of water to every one hundred quarts indicated by the gauge.

The proportion of the solution of sugar having been thus fixed upon, it is now put into a vat of sixty inches in diameter and ten in height, to be cooled by being stirred about. To what degree of temperature this cooling off must be continued depends on the stage of fermentation of the must to which the solution of sugar is to be added. If the fermentation of the must has not yet begun the solution of sugar may have a temperature of 30 R.=99.5 Fahr., but if fermentation has already taken place, the temperature of the solution should be equal to that of the must in fermentation. If the violent fermentation has come almost to a close the heat of the solution may stand at 30°, but if it is ended the whole mass of the must, after the solution has been added, should have a temperature of 20°. In this case let the temperature of the crude must in the cask be examined in order to ascertain the degree of heat required by the solution of sugar.

For instance, the cask or tun B, after the solution of sugar has been added, contains 620 quarts of crude must and 221 quarts of the solution of sugar—making 841 quarts. Requiring an average temperature of 20°, they contain ($20 \times 841 =$) 16,820° of heat.

Supposing now the 620 quarts of crude must to contain only 12° of heat—making 7,240°, it follows that the 221 quarts of solution of sugar adds to the must 8,580; these figures indicating the degrees divided by 221 (the number of the quarts dissolved) show the solution of sugar to require a temperature of 38° or 39°. As this temperature, however, is liable to be lowered on its way from the laboratory to the cask, it is desirable that its temperature, while in the laboratory, should be from 40° to 42°.

$$\begin{aligned} \text{Thus: } 20^\circ \times 841 \text{ quarts} &= 16{,}820^\circ \\ 12^\circ \times 620 \text{ quarts} &= 7{,}240^\circ \end{aligned}$$

$$9380 : 221 = 42\tfrac{98}{221}, \text{ or, in round numbers, } 42^\circ.$$

To mix the solution thoroughly with the crude must the contents of the cask should be well beaten with the wine-rod after every addition of 20 quarts of the solution.

The casks are now closed by protecting tubes, allowing the fermentation to proceed while keeping off the atmosphere. The vessels filled with water, into which the shorter joint of the fermenting tubes is put, being set in their places, the must is now left to ferment. To gather experience everything must be closely observed and all that may have a bearing upon the subject be accurately entered in the journal; for instance, the day and hour when the solution of sugar was added, beginning and close of the fermentation, temperature of the fermenting room, both at the outset and close of the fermentation, &c.

If the crude must has already completed the principal fermentation prior to its improvement, then the new or the audible fermentation takes place after the improvement—sometimes ten or twenty days after. This *audible* fermentation is known by the gurgling noise of gaseous bubbles forcing their way through the water used to keep the air from the must. This should not, however, cause any uneasiness, as by means of the quiet continuous after fermentation in the cask sufficient carbonic acid gas is developed, which, the air being excluded, spreading out on the surface of the must, protects and prevents it from growing mouldy.

The further treatment of wines that have fermented in rooms not heated is the usual one.

MAKING WINE OF THE PRESSED SKINS OR AFTER-WINE.

From the facts that a good middling wine should contain neither less than five nor over seven thousandths parts of free acids, and from seven to ten hundred parts of alcohol, that the quantity of acid can be so easily ascertained, that the grape sugar is so cheaply manufactured, and that every two pounds of sugar added to the must or pressed skins will produce one pound of alcohol, we deduce the following rules for making wine of the pressed skins:

1. Let one, or, if necessary, several vats be placed in the press-house, standing upon a support of twelve inches in height, and filled one-third full with pure water.

2. Let the cakes of the pressed skins be immediately put into those vats and crushed, or at least reduced to pieces of the size of one's fist, allowing no time for heating, which should be strictly prevented.

3. If such a quantity of skins have been put into the vat that the water is not sufficient to keep them covered, add more water, until it has risen a few inches above the skins.

4. Should the pressed skins rise to the surface and form a cover, on account of the fermentation having already commenced, they must, from time to time, be thrust under the water, until the vat has been filled up.

5. After the vat is almost full add no more water; but put in as many pressed skins, broken into small pieces, as can be crowded down with some effort.

6. After this, lay on the skins a wooden cover of a little smaller diameter than that of the vat, and load it with clean washed stones, (never with iron weights,) until it is seen that the skins, yielding to the weight, are still capable of being somewhat further compressed.

7. Let more water then be poured in until the cover is half an inch under water, after which, put another cover or clean linen over the vat.

8. After not more than about twenty-four hours, tap the must of the pressed skins, which will now readily flow, and put it into casks, then add the pressed skins and the press-must, filling up the casks only three-fourths, leaving room for the sugar yet to be added.

9. Before proceeding to make wine from the extracts of the skins, we should determine whether this wine is intended: *(a)* Either for consumption by itself, *(b)* or for mixing it with sour and poor wines.

10. In the former case, the extracts should contain, before any addition of sugar is made, at least seven-thousandths of acids, and as it is diluted by the alcohol generated from the sugar, the wine will, after all, contain but six-thousandths of acid. If these extracts contain less than seven-thousandths of acids, more fresh pressed skins must be added, and the whole mass be pressed again for twenty-four to thirty hours. As the extract cannot draw from the fresh pressed skins as much acid as pure water could, add to their already four-thousandths of acid three-fourths more of the pressed skins than at the first time. After pressing the mass of stronger extracts, soak the skins again with water. The weak extracts of some two or three thousandths of acids thus obtained may be now used, instead of water, for making extracts from fresh pressed skins.

11. Where the must of the skins is for the improvement of sour and poor wines, by adding more water its quantity of acid may be reduced to three-thousandths. In this case, it is best to wet the cakes of skins still under the press with the water required, and then give the whole another pressing.

12. After the quantity of acids desired has been prepared for the extracts, the quantity of sugar for every 100 quarts of different proportions of acids is to be computed, as before in the case of the must Let. B. Strictly speaking, the amount of sugar contained in the extracts of the pressed skins ought to have been previously ascertained. But as this is impossible, because the fermentation has begun, and thus a portion of the sugar has been already dissolved, this whole amount of the sugar may be set down at from two to four per cent., according to the ripeness of the grapes furnishing the pressed skins. The weight of 100 quarts of the extracts of the skins may therefore be put down at 235 pounds.

13. If the wine from the skins is to be used as such wine, add to it merely sixteen per cent. of sugar. If the grapes were already of such a condition that the sugar contained in the extracts from the skins amounted to no more than two per cent., then 100 pounds of such extracts require an addition of 14 pounds, 100 quarts, $=$ 235 pounds, require, therefore, $(235 \times 14 =)$ 33.4 pounds of sugar. In using grape-sugar of 84 per cent., 100 quarts of the extracts require 39.8, or in round numbers, 40 pounds, $(84 : 100 = 33.4 : x.)$

These (40 pounds) occupy a space in the liquid of $\frac{40}{3.5} = 11.4$ quarts. Adding the extracts for the pressed skins, 100 quarts, and allowing for the rise, 4.6 quarts, it shows that every 100 quarts of extract from the skins require a capacity of 116 quarts.

14. The acid contained in the wine from the pressed grape skins is thus determined. If the amount of acids contained in the extracts amount to seven thousandths, then 100 quarts

or 235 pounds will contain ($235 \times 7 =$) 1645 thousandths of acid. The must from the skins consists of extracts from the skins

skins consists of extracts from the skins	235 pounds.
Of grape-sugar	40 "
Total	275 "

The actual amount of grape-sugar was	33.4 pounds.
The extract from the skins contained ($2.35 \times 2 =$)	4.7 "
Total	38.1 "

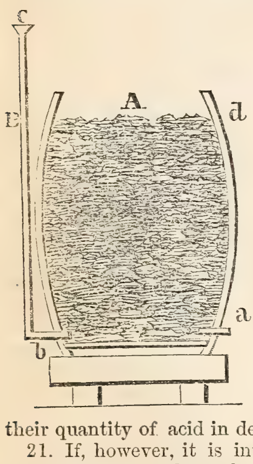
Deducting these 38.1 from 275, leaves 236.9 pounds of acid and water, to which are to be added some 20 pounds of alcohol formed from the sugar. Thus the amount of wine obtained will be 256. As those 1645 thousands of acid contained in 235 pounds of extracts from the pressed skins are now distributed in 256 pounds of wine, its quantity of acid will only be $1645 \div 256 =$ or 6.42 thousandths.

If all the sugar has been dissolved, the proportion of the alcohol in the wine would have been 7.8 per cent. But as a part of the sugar remains undissolved, we may reckon it about 7 per cent.

15. Should the wine from the pressed skins of the grapes be intended to be used for improving wines which are sour and deficient of alcohol, taking it as containing four thousandths of acids, we must add at least 15 per cent. of alcohol, and so double the amount of sugar than in the former case. If then 100 quarts of this wine of skins are mixed with 200 quarts of wine of 10 thousandths of acid and 6 thousandths of alcohol, we obtain 300 quarts of about 8 thousandths of acid and 9 per cent. of alcohol.

16. As no more water is to be added to the extracts from the pressed skins, the sugar that is added must be dissolved in a portion of the extracts. Take one quart of it to one pound of sugar. If the extract has already begun to ferment, care must be taken that the temperature of the liquid in melting the sugar be higher than 60° R. = 167 Fahr., otherwise a portion of the alcohol already formed in it will escape. A steam apparatus cannot be used for the reason already stated, that the extracts from the skins must not be further diluted.

17. Judging from the result of long experience, it seems best to use the extracts from the skins instead of water, for preparing the solutions of sugar necessary for the improvement of sour musts. For this purpose all the pressed skins of the sound grapes should be stamped in casks, as before described.



18. To obtain from the skins thus treated every particle of grape juice, without pressing them again, the following method is recommended: Near *d*, some two inches below the edge, let a hole of one inch in diameter be made with a gimlet, for inserting a tin tube from six to eight inches in diameter, under which place a tub for the reception of the extracts from the skins. Then pour water in the funnel *c*, till it rises through the skins, thoroughly soaking them, and running out through the tube into the tub below. As more water is required to improve the must than for soaking the skins, we may continue to pour water into the funnel until no more acid can be discovered in the liquid flowing through the tube.

19. If this method is carried on extensively, a vat should be placed on a platform of sufficient height and filled with water by means of a hand pump, and a spigot be used to regulate the water flowing off at pleasure. Thus, by means of pipes arranged for the purpose, the water may be conducted to all the casks set up around the platform in a semicircle.

20. It is also self-evident that if extracts are used, instead of water, for the improvement of the must, regard should be had to their quantity of acid in determining the solutions of sugar required.

21. If, however, it is intended to let the extracts from the skins ferment by themselves, and in order to make such a kind of wine for use as a drink, the platform must have room enough for another vat to receive the extracts that have little acid, and which are made to pass through fresh skins to acquire the quantity of acid desired.

In whatever way the extracts from the skins are used for making wine, this much is certain: that every producer of wine will, even by the smallest experiment, be led to the conclusion to send in future only the skins of rotten grapes to the distilleries.

TREATMENT OF WINES KEPT ON STORE.

1. Though the constituent parts of the grape juice which are capable of turning into yeast, and which we call the yeast substance, viz: the nitrogenous substances, as gluten, vegetable albumen, extractive principle, are indispensable to the must for producing fermentation, and thus changing it into wine, yet they endanger its keeping quality and perfections. In the making and treatment of wine the whole attention must, therefore, be directed to the removal of these matters.

2. The yeasty substance does not turn at once into yeast, but gradually.

3. In proportion as alcohol and carbonic acid gas are formed from the sugar, during the progress of the first and second fermentations, a part of the yeast loses its effect, and new yeast is formed.

4. The latter takes place the less often the lower the temperature is. At a temperature of 10° = 54.5 Fahrenheit, it can hardly be noticed.

5. Even wine which is perfectly clear and transparent may still contain yeasty matter in solution, as it will not make the liquid cloudy until after having been turned into yeast.

6. As long as there exists a particle of yeasty matter no sugar can remain in the same liquid, but it is formed into alcohol and carbonic acid.

7. If, after the solution of all the sugar, more yeast substance remains, it will allow no alcohol near it; but it forces the alcohol to combine and form acetic acid, with the oxygen of the atmospheric air, some of which is always contained in the wine, or penetrates into it as explained above.

8. The conversion of sugar into alcohol and carbonic acid, which takes place as long as yeast substance exists, goes on the slower after the audible fermentation, the lower the temperature of the cellar is, on which account it is also called the inaudible fermentation. It becomes more lively again, causing even a turbidness of the wine, when the wine grows warmer at the season of the rising of the sap, the flowering of the grapes, &c.

9. This greater activity of the second fermentation, this new movement, commencing when the season becomes warmer, has in itself no injurious effect on the quality of the wine. It is so only as the wine, because of it, is not saleable for some time, and because the moment is urged forward when all the yet undissolved sugar will begin to allow the yeast matter present to exert its injurious influence on the alcohol. But this new fermentation may become very injurious if the wine has not been previously drawn off, for the yeast contained in the sediments will then rise again and add to its sourness.

10. After the sugar is dissolved, and in case the yeast substance is still present, which, according to experience, is found in all German white wines, the conversion of part of the alcohol—that is, the formation of acetic acid—is the more injurious the larger the tuns are, and the more neglect there is in keeping them always well filled, because in this case atmospheric air penetrates through the pores of the wood, especially through those of the bung, and fills up the empty space. Thus even our finest wines frequently contain signs of acetic acid.

11. The relative proportions of sugar and yeast matter is quite the reverse in most grapes, so rich in sugar, of Southern countries. In the wine made from the must of such grapes there remains a quantity of sugar undissolved (not converted into alcohol) after all the yeast substance has turned into yeast, which separates when a portion of sugar has been converted into alcohol and carbonic acid.

12. Such wines as continue to contain sugar still undecomposed, after the total disappearance of yeast matter, change but little, even under the access of air, the red wines excepted, in which the coloring substance plays the part of the yeast-matter.

13. The grapes rich in nitrogenous matter in proportion to their quantity of sugar produce the so-called dry wines, all the sugar being gradually decomposed. Their alcoholic acidulous taste is agreeably softened by some sweetness only in the first years. But the so-called liquor wines are produced from grapes which are naturally rich in sugar, and contains only a small quantity of yeast matter, or when their already large amount of sugar is artificially increased by allowing the grapes to undergo the process of after ripening and drying up. Or these wines may also be produced by partly boiling the must and adding occasionally sugar, (*vins cuits*,) for by boiling the must not only is the proportion of sugar increased, but the amount of nitrogenous substances is lessened, as a portion of them will coagulate and remain in the shape of scum.

14. A high degree of temperature acts on the nitrogenous combinations in the wine similarly to a moderate cold. Experience of several years has shown that wines exposed to a temperature of 1° above to 4½° below zero of R = 29.7 to 22 Fahr., without allowing them to freeze, will be more thoroughly liberated from nitrogenous combinations in from 6 to 8 weeks than by being kept in store for 18 months. Their development will be accelerated in the same ratio.

From the foregoing facts we deduce the following rules for general application:

1. The cellar, in which the wine is to attain its full development, should be kept as cool as possible. The air-holes looking Southward should, therefore, always be kept closed in the warmer seasons. In the absence of any other air-holes, these should only be opened from time to time, in cool nights, for the purpose of ventilation. For the same reason the doors should be closed immediately after entering the cellar.

2. If we desire to obtain, in the shortest possible time, ready wine with keeping qualities for transportation, we should secure it when the colder season begins, keep it for some four, six, or eight weeks in casks of one-half to one Ohm, (20 to 40 gallons,) placed on a level with the earth, and which is capable of being heated, and maintain the temperature at one above to four and a half below zero of R. = 29.7 to 22 Fahr., by opening doors and windows or by the application of a moderate heat, as the temperature of the atmosphere may require. After the wine has been thus exposed to the action of the cold, the longer the better, it is put in casks slightly fumigated with sulphur, taken back to the cellar, and immediately clarified.

3. The casks should always be kept full, even if they have to be filled up every three days. In order to let as little air as may be come in contact with the wine, while they are filled, the bungs should extend from an inch or two into the cask when full, and through the centre of this bung bore a vent-hole of one-half inch wide. To prevent the air from penetrating the bung, dip their heads in a melted and yet warm mixture of one part of wax and one part of tallow. After this bung has been driven into the bung-hole, close the small hole in the bung by a tight peg made in the shape of the neck of a violin-peg, that it may be easily taken out. To fill up the cask nothing is required but to take out this peg, and pour in through a small funnel fitted to the bore.

4. It is, however, more convenient to use filling bottles for keeping the casks constantly filled, (on which see the treatise of Mr. Gall, "The Filling Bottle and its Use," Die Füllflasche und deren Anwendung Treves, F. A. Gall, 1854.)

5. In filling up casks new, a fresh wine should never be used, as this imparts to the wine in the cask some of the dissolved gluten or lees (yeast) already formed.

6. The wine should be drawn off at least three times during the first year, to separate it as soon and as completely as possible from the sediments, since they have already become inactive, yet still contain some active lees or yeast. The second drawing off should, by all means, take place before the commencement of the warmer season at the end of February or at the beginning of March, (later in this country.)

7. In adopting my method of subjecting wines that have ceased to ferment, without risk to a new fermentation, I recommend to collect every year, about the month of July, the necessary quantity of grape blossoms, for the purpose of preparing bouquet-essence, in order to supply from time to time the finer wines with fresh bouquet in place of that which has gradually, more or less, evaporated.—(See Gall's Instructions in Alfred Faber's Treatise: "The improvement of Wine" Trier, 1853. Zur Weinveredlungsfrage, Trier, 1853.)

8. The preparation of isinglass for fining the wine is too generally known to require description; but it is less so, that if kept in a dissolved state longer than three or four days, it will lose its effects in proportion to the time it is so kept. When added in this state to the wine it will, before it perfectly fines, be dissolved, and impart a bad taste to it. Fresh isinglass should always, therefore, be prepared, (two ounces to a hogshead, Fuder,) and the wine be drawn off at least eight days after being fined.

METHOD OF IMPROVING THE WINE AFTER ITS FERMENTATION.

This method of making good wine from sour wine does not consist in the addition of any foreign substance, nor is it any artifice of chemistry. It is simply bringing the wine which is to be improved back to the stage of a fermenting must. This is done—

1. By adding to the sour wine that quantity of sugar and water, of which it has too little, in proportion to its amount of acid, in order to make good must. 2. By giving it a temperature necessary for producing a new fermentation. 3. By adding the proper fermenting substance in such a quantity as is required for the dissolution of the sugar added. 4. By protecting this mixture from any contact with atmospheric air until the new fermentation commences, which often takes place several weeks after. The air will penetrate even through the pores of the casks. The sour wine, which has thus been reduced into the condition of a fermenting must, is, after the commencement of the new fermentation, in the same condition as a normal must which has gone halfway through the process of fermentation. Its principal constituent parts are free acids, water, alcohol, still active lees, and undissolved sugar. The latter, as in the actual must, is, during the process of fermentation converted into alcohol and carbonic acid, the lees settling in the same measure as it loses its action. Such wine that has been reduced to the state of must requires, all other circumstances being similar, the same length of time as any other original normal must.

GRAPE-CULTURE AND WINE-MAKING.

A BRIEF HISTORY OF GRAPE CULTURE AND WINE-MAKING, ANCIENT AND MODERN, WITH A COMPREHENSIVE VIEW OF THE PRESENT EXTENT OF THE WINE PRODUCT OF THE WORLD.*

BY DANIEL R. GOODLOE, WASHINGTON, D. C.

It may be regarded as a highly interesting and gratifying evidence of the progress of civilization on this continent that general attention is turned to the cultivation of the grape and the manufacture of wine. The newly awakened interest in this subject is manifested in the number and variety of books upon grape culture which have appeared within the last few years, and in the correspondence of this office, but more especially in the space devoted to it in the agricultural periodicals of the country, and in the numerous graperies and vineyards which have been planted within the same brief period. There seems to be a general recognition of the fact that in the scramble for wealth and the greed for wide possessions, as well as in the inherent difficulties of our situation—thrown as we have been upon a new continent—we have too long neglected one of the most ancient and useful arts of life; an art which has in all ages been the fruitful source of comfort and luxury, of health and happiness, to the masses of mankind. The neglect of this important and beautiful department of agriculture is the more remarkable since our country embraces every degree of latitude and every variety of climate and soil in which the grape is known to flourish.

The indifference and apathy which the American people have heretofore manifested on this subject can only be explained by a reference to the fact that we have sprung mainly from that country of Europe which, because of its moist atmosphere and cold climate, has given least attention to grape culture. Great Britain lies north of the fiftieth parallel of latitude, where it is next to impossible to cultivate the vine in the open air, except in some favored spots; and while our English ancestors knew little of the culture of the grape, their government adopted an unwise system of taxation, about the period of the settlement of this country, which deprived the masses of the use of wine, and compelled a resort to alcoholic or malt liquors. That these coarse and strong drinks are the cause of a degree of brutality and drunkenness not to be seen in wine-producing countries is the universal remark of travellers. France produces nine hundred million gallons of wine annually, five-sixths of which is consumed by the common people, and yet the French people are not noted for drunkenness. A similar state of things exists in Spain and Portugal, in Italy and southern Germany, in all of which countries wine is consumed as an ordinary beverage, yet all of them compare favorably with England and the United States in point of sobriety and decorum.

We, who only consume wine as it is sold at the rate of one or two dollars the bottle, can scarcely believe that in Europe it is a cheap article of food in which the common people indulge daily. But when it is considered that the wine crop of France, of eight or nine hundred million gallons, is worth only about one hundred million dollars, or ten or twelve cents per gallon, the mystery is explained. At twenty-five cents per gallon wine would be a cheap article of food, of which the poorest classes in this country could partake. With ten times the area of France, with almost an equal population, with a greater diversity of soil and climate, is there any good reason why the United States may not produce at least as much wine? France devotes five million acres to the cultivation of the vine, or a space less in extent than two-thirds of the State of Maryland. The value of the product, even in that country, at the seemingly low average price above stated, is immense; but in this country, where prices generally range higher, and where all classes are able to indulge in greater luxury, the profits on the production, when our people shall become familiar with the various processes of rearing grapes and manufacturing wine, must be far greater than in France. This point will be abundantly established in the course of this paper in remarks specially relating to French wines.

It is to be remarked that the celebrated wines of France and of other parts of Europe constitute an insignificant proportion of the wine product. These celebrated wines are exported to various parts of the world, and by the high prices they bring the impression has been produced in this country that wine is a luxury which none but the rich can afford

* The necessity of condensation has permitted the introduction into this history of little more than a brief recital of facts bearing directly upon the subject; and whenever this could be best accomplished by quoting the language of the various authorities used it has been freely done, but with due credit in every possible instance. A single writer, Henderson, has been drawn upon copiously in this manner, the thread of his narrative being taken up and transferred literally from the various parts of his ample quarto, which, if not out of print, appears to be accessible to but few, and altogether unknown to many, even of the learned upon the subject.

to enjoy. No greater mistake can be made. The facts already stated show that wine is a very cheap article of daily food in all those parts of Europe which lie in the latitude of the United States. Ninety-nine in every hundred gallons of the wine produced in Europe, even in Burgundy and Champagne, belong to the class of ordinary, and are habitually used by all classes in those countries. The majority of these wines are good and wholesome, and the very inferior qualities are distilled or made into vinegar.

The proverbial difficulty of changing the habits of a people is applicable rather to former times and other countries than to ours. Such is the facility of diffusing information among the people of this country, and such their habit of innovating, that no reason can be perceived why the United States may not become, in a very few years, an extensive wine-producing country, taking rank in this particular with France and Spain. It may require a long time to rival those countries in the production of the best wines, because it requires accumulated experience, from generation to generation, to learn the best methods of culture, and to apply them to the best localities; but in the production of good common wines there is no reason why the United States may not at once enter into successful competition.

It is difficult to overrate the importance of this subject with reference to the industrial, the social, and the moral interests of society. The introduction of a new branch of agriculture, which, within a dozen or twenty years, may rival the most important of those now existing, is of itself a consideration which must arrest the attention of the statesman, the political economist, and the philanthropist. Every new agricultural pursuit tends directly to withdraw surplus and underpaid labor from its present occupations, and to engage it in a more profitable way. To diversify labor is to increase its resources and to raise wages. Two millions of the people of France are engaged in the culture of the grape and the manufacture of wine. There is ample room in the United States for an equal employment of labor in the same pursuit. The home market alone would be sufficient to justify wine-making on the extensive scale here suggested—a fact which must be apparent, if we consider that of the eight or nine hundred million gallons of wine made in France annually, only from thirty to fifty million gallons are exported. France, as has been stated, is the great consumer of her own wines, at the rate of from twenty to twenty-five gallons per head for every man, woman and child in the empire.

The celebrated English agriculturist, Arthur Young, who travelled in France toward the latter part of the last century, states in his valuable work that the cultivation of the vine requires a smaller outlay of capital than any other branch of agriculture. "The nature of the culture depending," says he, "almost entirely on manual labor, and demanding no other capital than the possession of the land and a pair of arms; no carts, no ploughs, no cattle, necessarily leads the poor people to this species of property." This circumstance, in an over-peopled country like France, where the practice is to subdivide little farms until they become mere garden spots, owing to the deep attachment of the people to the place of their birth, is regarded as a source of poverty to the laboring classes. But in a country like the United States, where land will be abundant and cheap, as compared with France, for centuries to come, the inducements held out to the poor to become independent cultivators are among the greatest blessings which Providence has vouchsafed to us. In France, Mr. Young thinks, it is a misfortune to the poor to be possessed of these little properties; but, he adds, "A poor family can nowhere be better situated than in a vine province, provided they possess not a plant. Whatever may be the season they are sure of ample employment among their richer neighbors, and to an amount, as we have above seen, thrice as great as any other arable lands afford. That culture which demands £2 12*s.* in hand-labor only, (per acre,) whether there be a crop or not, and which employs women and children of all ages, ought not, surely, to be condemned as the origin of distress among the poor. Attribute the fact (the poverty of the small vine-growers) to its true cause, the desire and spirit of possessing landed property, which is universal in France and occasions infinite misery." It is clear that what is an evil attendant upon its vine-culture in France, viz: the facility it affords to poor men to become independent proprietors, would be a blessing in our country, where land is abundant.

If we have reference to the health, the comfort, and the sobriety of the people, the importance of grape and wine culture becomes still more striking. Adam Smith (Wealth of Nations, B. IV, chap. III) says: "The cheapness of wine seems to be a great cause, not of drunkenness, but of sobriety. The inhabitants of the wine countries are, in general, the soberest people in Europe. Witness the Spaniards, the Italians, and the inhabitants of the southern provinces of France." Montesquieu, indeed, maintained that "drunkenness predominates over all the world in proportion to the coldness and humidity of the climate." "Go," he observes, "from the equator to our pole, and you will find drunkenness increasing with the degree of latitude. Go from the same equator to the opposite pole, and you will find drunkenness travelling South, as on this side it travels towards the North." If the fact were as stated by Montesquieu, it would not be inconsistent with the explanation given by Adam Smith, for the country where the greatest sobriety exists is that which produces and

consumes wine, while the countries in which drunkenness prevails to the greatest extent are those which produce no wine and consume but little. That there is no necessary connexion between degrees of sobriety and degrees of latitude is proved by the example of the United States. Here the theory of Montesquieu is utterly at fault, while that of Adam Smith holds good. The national vice of drunkenness is not confined to any latitude or section, but manifests itself in equally deplorable results in the extreme South as in the extreme North. The friends of temperance have nothing to fear, therefore, from the introduction of wine culture into this country; and it is submitted that the introduction of that culture will have the most beneficent effect upon the morals of the country.

ARMENIA.

The cultivation of the grape and the manufacture of wine are among the most ancient and universal arts known to mankind. They are coeval with the dawn of civilization, and coextensive with its existence in Asia and Europe, if we except England and those parts of the continent which are too cold to produce the grape. It is singular that the first labor of Noah after the flood was to plant a vineyard and to make wine. In Genesis, chap. 9, v. 20, we read: "And Noah began to be a husbandman, and he planted a vineyard, and he drank of the wine and was drunken." Some commentators, in their zeal for the reputation of Noah, undertake to maintain that this was his first acquaintance with wine, and that the art of making it was unknown to the people before the flood; but the probabilities seem to be all the other way. The fact that Noah planted a vineyard implies that he had the experience of ages to guide him. He is not described as experimenting with wild vines, with whose nature he had little or no acquaintance, but being a husbandman, he planted a vineyard, and made wine of the grapes. He must have derived his knowledge of the vine and its fruit and of the expressed juice of that fruit from his antediluvian experience, else his planting a vineyard would have been a strange freak, little characteristic of the husbandman. Indeed, it is evident, from the brief narrative quoted, that the planting of vineyards was a regular branch of husbandry which Noah derived from his ancestors. The art of manufacturing wine, which is a very simple process, would necessarily result from the cultivation of the grape. To press out the juice and preserve it in vessels for future use would suggest itself as the readiest if not the only mode of preserving the fruit beyond the season of its ripening. Fermentation would naturally take place, and wine would be the necessary result. It is not at all probable that these simple processes would escape the observation of mankind for two thousand years, from Adam to the flood, and that they should all at once flash upon the mind of Noah. It is probable that the art of vine dressing and wine-making are coeval with Adam himself, who lived to be nine hundred and thirty years old, during which time he could not have remained ignorant of the excellencies of a fruit so common in the portion of the earth where his lot was cast. The vineyard of Noah is conjectured to have been planted about a league from the city of Erivan, in Armenia, upon the identical spot where he and his family resided before the flood. This city is situated southeast of the Black sea, and immediately south of the Caucasus mountains, in latitude forty. The Armenians on this account claim precedence in the art of planting vineyards, but the Persians also set up a traditional claim to the same honor. It is related of the Armenians of Chiulful that they were formerly great drunkards, but owing to the peculiar excellence of their wine they were not made quarrelsome over their cups, like their fellow Christians of the western world. On the contrary, when their spirits were greatly stimulated by imbibing the fragrant nectar, their religious enthusiasm broke forth in incessant prayers to the Virgin.

EGYPT.

The invention of wine was ascribed by the ancient Egyptians to Osiris, by the Greeks to Bacchus, and by the Romans to Saturn. It is strange that some authorities represent the ancient Egyptians as being averse to wine, and deny that the country produced any of it. "A trait," says M. Savary, "which the best authors of antiquity give evidently demonstrates that the Greeks were wrong in wishing to establish a perfect similitude between Bacchus and Osiris. The first was honored as the author of the vine, but the Egyptians, far from attributing its culture to Osiris, held wine in abhorrence." Plutarch says, too, that "the Egyptians never drank wine before Psammetichus, holding this liquor to be the blood of the giants, who, having made war on the gods, had perished in battle, and that the vine sprung from the earth mingled with their blood; nor did they offer it in libations, thinking it odious to the gods." "This sacred fable," says Savary, "passed from Egypt to Persia, and Clemens Alexandrinus tells us the Magi most carefully abstained from wine. There was a law which forbade its use among the Arabs, and Ovington affirms that the Bra-

mins at present detest the liquor, and hold it in equal horror with the Manes, who supposed it to be the blood of demons. Whence this Oriental aversion to wine originated it would be difficult to say, but exist it did, which probably was one reason why it was forbidden by Mohammed. Perhaps we should seek for the cause in the curse of Noah pronounced upon Ham, who insulted his father, finding him drunk. But whether or no, the Egyptians detested it, and could not attribute the cultivation of the vine to Osiris." Herodotus says: "The Egyptians use wine made from barley, for their country does not produce the vine."

On the other hand, it is affirmed by Diodorus Siculus, in his third book, that Bacchus, or Osiris, is reported to have taught the Egyptians the management and use of the vine, as also of wine, apples, and other fruit." The Israelites, murmuring against Moses in the desert of Zin, said: "And wherefore have ye made us come up out of Egypt to bring us in unto this evil place? It is no place of seed, or of figs, or of vines, or of pomegranates; neither is there any water to drink."

This testimony of Moses as to the existence of the vine in Egypt, in his time, must be regarded as greatly preferable, apart from the sacred character of the book, to that of Herodotus and Plutarch, Greek historians. The former may be regarded as the incidental testimony of a whole people, who resided for centuries in the country, and therefore unquestionable; while the latter picked up their information as best they could upon hearsay. The testimony of the Hebrews, murmured forth in their complaints against Moses in the wilderness, is confirmed by the testimony of Diodorus, quoted above, and in other passages which might be cited. He says in his first book that wherever the vine was not found Osiris taught the people to make a drink from barley, called zythum or tythus; and in various passages he speaks of the use of wine at feasts and entertainments. Psammetichus, prior to whose reign Plutarch says the Egyptians used no wine, made himself master of Egypt 652 years before Christ—a period comparatively modern in Egyptian history. The Exodus of the Hebrews from Egypt took place nearly nine hundred years prior to this king's reign, and we have seen that they deplored the loss of the vine, as they did the flesh pots during their long sojourn in the wilderness. David in the Psalms testifies to the same effect, when he says, (Ps. 78, v. 47:) "He destroyed their vines with hail, and their sycamore trees with frost." And again (Ps. 105, v. 33:) "He smote their vines also and their fig trees, and brake the trees of their coasts." A reference to the context will show that these were the curses visited upon the Egyptians for their cruelty to the Israelites. In the 80th Psalm, 8th verse, it is said: "Thou hast brought a vine out of Egypt; thou hast cast out the heathen and planted it." This is only a figure, it is true; but its beauty and propriety would be destroyed by the supposition that Egypt produced no vines. On the contrary, the inference is legitimate that Egypt was in those early ages celebrated for its vines.

Another passage from Genesis by a still stronger implication attests the cultivation of the vine in Egypt, if, indeed, it be not a direct assertion of the fact, more than eighteen centuries before Christ.—Gen. chap. 40, v. 9–13: "And the chief butler told his dream to Joseph and said unto him, in my dream behold a vine was before me; and in the vine were three branches; and it was as though it budded, and her blossoms shot forth; and the clusters thereof brought forth ripe grapes; and Pharaoh's cup was in my hand; and I took the grapes, and pressed them into Pharaoh's cup, and I gave the cup into Pharaoh's hand. And Joseph said unto him, This is the interpretation of it: The three branches are three days: yet within three days shall Pharaoh lift up thine head, and restore thee unto thy place; and thou shalt deliver Pharaoh's cup into his hand, after the former manner when thou wast his butler."

Hellanicus, a Greek historian cotemporary with Herodotus, who is said to be the first who employed chronology in history, and who, for that reason, is entitled to speak with authority, says that "wine was first known at Plinthion, a town of Egypt; hence the Egyptians are thought to derive their immoderate love and use of this liquor, which they thought so necessary to human bodies that they invented a sort of wine, made from barley, for the poorer sort, who wanted money to purchase that which was pressed from grapes."

The contradictory accounts which have come down to us in regard to the production and consumption of wine by the ancient Egyptians and Chinese, (for the same confusion exists in the Chinese histories,) are probably traceable to the fact quoted from Savary, viz: that certain religious sects or orders among the Orientals hold wine in great abhorrence. This was true of the Magi, of the Bramins, and probably of the ancient Egyptian priesthood. The Greek writers, with an imperfect knowledge of the languages of these nations, coming in contact with these classes, or with their writings, might easily conclude that the whole nations to which they belonged were violent haters of wine; whereas their abhorrence of it probably grew out of the excessive use of it by their countrymen. We have seen a similar abhorrence of ardent spirits manifested in this country by religious and moral men; but it would be a great mistake in the Japanese to infer that the sentiments of temperance men are in strict accordance with the practice of the people. The Mohammedan religion strictly forbids the use of wine, and until commerce and travel brought the nations of the West

into frequent intercourse with those people, the impression prevailed that the practice of the Mussulmans coincided with the precepts of the prophet. It would be equally an error in the Mohammedan to infer from reading the New Testament that the professors of Christianity never go to war, nor quarrel with their neighbors.

The Mareotic wine was a white wine made in the vicinity of the lake Meroe. It is alluded to by Horace and Athenaeus. Another Egyptian wine was called the Taeniotic. They were, according to Dr. Henderson, in his elaborate and valuable history of ancient and modern wines, of unrivalled excellence. "The former," says he, "which was sometimes called Alexandrian, from the neighboring territory, was a light, sweetish, white wine, with a delicate perfume, of easy digestion, and not apt to affect the head; though the allusion of Horace to its influence on the mind of Cleopatra would seem to imply that it had not always preserved its innocuous quality." Lucan compares the wine of Meroe, which Cleopatra produced at the celebrated feast she gave to Cæsar, to the finest of the Roman wines, the Falernian. The Taeniotic, according to Henderson, was a gray or greenish wine, of greater consistence and more luscious taste than the Mareotic, but accompanied with some degree of astringency, and a rich aromatic odor. These, with the wine of Antylla, also produced in the vicinity of Alexandria, were, according to Athenaeus, the only celebrated wines made from the numerous vineyards which adorn the banks of the Nile.

That there is anything in the soil and climate of Egypt unfriendly to the growth of grapes is disproved by the abundant testimony of modern travellers. "Dr. Pococke," says an Irish author, Donovan, "during his travels through Egypt, met with numbers of vineyards, from the grapes of some of which the Christians made very good wine. Many of these vineyards were on the banks of the Nile, which still, as it ever did, overflows its boundaries, and inundates the country. Other travellers report that grapes are grown throughout all the adjoining countries, and on the shores of the Levant."

CHINA.

According to the Abbe Grosier, China has produced an abundance of grapes from the earliest times. "Those who believe that the vine was not known in this empire until very late," says he, "and that it was brought hither from the West, labor under a great mistake. All the literati assure us that the vine has been known and cultivated in China from the remotest antiquity. What is said in the Tcheou-ly respecting the duty of the mandarins intrusted with the care of the emperor's gardens, cannot be understood of anything else but of the vine; but the Tcheou-ly is considered as the work of the celebrated Tcheou-kong, brother of Vou-vang, who mounted the throne in the year 1112 before Christ. However this may be, it is certain that there were vines in Chan-si and Chen-si several centuries before the Christian era, and that a sufficiency of them was cultivated to make abundance of wine. Le-ma-tsien remarks that a private individual had made ten thousand measures. There was a time when the inhabitants of Pe-tshe-ly, Chan-tong, Ho-nan, and Hong-quang applied themselves equally to the culture of vines. The wine which they made had the property of keeping several years, when put into pitchers and buried in the earth; and 'this liquor,' says the historian, 'was become so common that it caused great disorders.' The songs which remain of all the dynasties since that of Yven to Han give us reason to believe that the Chinese have always been fond of wine made from grapes. The Emperor Onenti, of the dynasty of Ouei, celebrates it with a lyric enthusiasm worthy of Horace or Anacreon; and we find in the large Chinese Herbal, book 133, that wine made from grapes was the wine of honor, which several cities presented to their governors and viceroys, and even to the emperor. In 1373 the Emperor Tai-tsou accepted some of it for the last time from Tai-Yuen, a city of Chen-si, and forbade any more to be presented. 'I drink little wine,' said the prince, 'and I am unwilling that what I do drink should occasion any burden to my people.'"

"It appears," continues the Abbe, "that the vine has experienced many revolutions in China. It has never been excepted when orders have been issued for rooting up all those trees that encumbered the fields destined for agriculture. The extirpation of the vine has even been carried so far in most of the provinces under certain reigns that the remembrance of it has been entirely forgotten. When it was afterward allowed to be planted, it would appear, from the manner in which some historians express themselves, that grapes and the vine began then to be known for the first time. This probably has given rise to the opinion that the vine has not been long introduced into China. It is, however, certain, without speaking of remote ages, that the vine and grapes are expressly mentioned in the Chinese annals under the reign of the Emperor Vou-ty, who came to the throne in the year 140 before the Christian era; and that, since his time, the use of wine may be traced from dynasty to dynasty, and, as we may say, from reign to reign, even to the fifteenth century. With regard to the present state of the culture of vines in China, we know for certain that

the emperors Kang-hi, Yong-tching, and Kien-long, now on the throne, [latter part of last century,] caused a number of new plants to be brought from foreign countries; that the three provinces of Ho-nan, Chang-tong, and Chan-si have repaired their former losses; that the large cities of Tai-Yuen and Ping-Yang, in Chan-si, are famous throughout the whole empire on account of the great quantity of dried grapes that are procured from their environs, both for the table and medicinal purposes; and that the province of Pe-tcheli, at all times fruitful in vines, produces so many at present that there are fourteen of its districts celebrated for their raisins, which are preserved long, and sold in Pe-king at a very moderate price. The raisins most in request in China are those which, as we have said, come from the country of Ha-mi."

M. Huc, the Jesuit missionary, whose valuable book of travels in China appeared only a few years ago, reiterates the above historical account of the vine from the Abbe Grosier, and adds: "The annals contain accounts of various species [of the vine] that were brought from Samarcand, Persia, Thibet, Tourfan, Ha-mi, and other countries. It would even be easy to show that grape wine was in use under every dynasty and every reign to the fifteenth century. At present there still exist in China several excellent kinds of grapes." The Chinese of our day, however, do not, he says, cultivate the vine on a large scale, and do not make wine of grapes; the fruit is gathered only for eating, either fresh or dried. It is the policy of the government, he relates, to suppress the cultivation of all luxuries, in order that the whole territory of the empire may be devoted to the production of grain and vegetables for the sustenance of the immense population. But this benevolent design of the government is completely frustrated by the invincible passion of the people for strong drink; and, instead of proving a blessing, this sumptuary law has inflicted the greatest calamity upon the people. In default of the grape, the Chinese now manufacture a spirituous liquor, says M. Huc, from corn and rice. "The most commonly used is made from the fermentation of rice. It is a kind of beer, the taste of which is sometimes very agreeable. That of the best quality comes from Chao-king, in the province of Tche-hiang." Europeans regard it as detestable. But M. Huc relates an amusing mistake of an English connoisseur in wines, upon whom a bottle of it was imposed as the best Spanish wine, and who gave it to his friends, who fell into the same mistake. The Chinese, he says, "were acquainted with the manufacture of this liquor at least twenty centuries before the Christian era." The Chinese, he informs us, were not acquainted with the process of distillation before the thirteenth century, when it was discovered by accident. Since that period they have made brandy of corn. "The brandies of the North are made principally with large millet (Holcus Sorghum.) There exist considerable manufactories, where its product is passed several times through the still, and thus obtains the strength and energy of alcohol. These liquors always retain an unpleasant taste; but it may be got rid of by macerating green fruits or aromatic herbs in them. The Chinese, however, do not care about these niceties; they drink it with avidity; and they are so little in the habit of drinking anything cold that they have even their brandy served up to them hot. This horrible drink is the delight of the Chinese, and especially of those of the North, who swallow it like water. Many ruin themselves with brandy, as others do with gaming. In company, or even alone, they will pass whole days and nights in drinking successive little cups of it, until their intoxication makes them incapable of carrying the cup to their lips."

So completely do the Chinese inebriates saturate themselves with this fiery liquor that M. Huc was assured, upon unquestionable authority, of the frequent occurrence of the combustion of the body resulting from accidental collision with fire. When the body is in such a state, a contact of the breath or of the person with flame is sufficient to set the whole man in a blaze.

"The Chinese law," he continues, "prohibits the fabrication of rice wine and spirits, on the ground that corn ought to be taken the greatest care of in a country where all the labor and industry of the inhabitants are scarcely sufficient to supply the food required for the immense population. But these laws are pretty much like those which prohibit gaming—a perfect dead letter; a fee to the mandarin removes all difficulties. The large establishments called Chao-kouo require a permission from the government to distil brandy, and this is sold to them only on condition that they shall employ in their distilleries nothing but grain that is spoiled and unfit for any other purpose; but that does not form the slightest hindrance to their using the very best grain the harvest produces."

"Gambling and drunkenness, then," continues M. Huc, "are the two permanent causes of pauperism in China," &c.

It must be clear to every reader that the suppression of the vine, and the inevitable substitution of malt and distilled liquors in place of wine, have been attended with disastrous consequences to the health, the morals, and the prosperity of the people of China.

The Chinese, with a degree of eccentricity which renders them as much the antipodes of the Western world in manners and customs as in geographical position, while discouraging

the manufacture of wine from grapes, are said actually to make a substitute for it of the flesh of sheep and lambs! This absurdity would seem almost incredible, if it were not well attested by travellers.

INDIA.

It is singular that the country which, according to judicious historians, originated the myth of Bacchus, the god of wine, was never at any period a wine-producing country, except to a very limited extent. Dr. Anthon, in tracing the origin of the various names of this fabled deity, draws the conclusion that Bacchus, Osiris, and Schiva were one and the same.

On this subject Mr. Redding, in his History of Wines, ancient and modern, says: "The territory of India was the fabled birthplace of Bacchus. Sir W. Jones compares to him Bala Rama, and Sumdévi is the Hindoo goddess of wine. India at present produces little or none of the juice of the grape, except in the Northern parts between the Sutlej and the Indus, bordering upon the former river. To the Southward the climate is too hot, and the soil too rich for vine culture. The Indians said, according to Diodorus, that Bacchus first taught them the art of pressing grapes and making wine, and that he resided in his capital, Nysa, in the modern Punjaub; that he ruled India with justice, and was after his death adored as a god. All this, whether fabulous or not, only relates to the territory west of the Sutlej, or, as it was anciently called, the Hyphasis river. Eastward of this the arms of Alexander never penetrated, nor does it appear the ancients knew anything of the country. At Lahore, beyond the Sutlej, wine of good quality is made, and all the way from thence to Candahar, and Northward to and in Cashmere, vines are planted and wine is manufactured. That of Cashmere resembles Madeira. Wine is made in Nepaul, where the best is prepared in the common way. The must, or unfermented juice, is called *sike.* Hot water is poured upon the mash and residue, and a less worthy sort is thus manufactured. At Candahar wine is forbidden to be drunk, according to custom in Mohammedan countries; but that drunkenness does happen is plain from the punishment attached to those who are discovered intoxicated. They are seated on an ass with their faces toward the tail, and so led through the streets, preceded by the beating of a gong, and surrounded by a crowd of vagabonds."

"Wine," continues Redding, "was once made in Golconda, upon the hills. During the reign of the great Akbar, whose tomb near Agra has lately been repaired, though wine was forbidden, yet it was evidently used in this noblest city of his empire. It is related that Akbar, standing in need of good gunners, got some from on board English vessels trading to his dominions. One of these who, from the dry character of the man, was evidently a tar, being ordered to fire at a carpet suspended as a mark that the Emperor might see his dexterity, purposely shot wide of it. He was reproved and told he was an impostor; upon which the fellow answered, with great pretended humility, that his sight was bad from having been debarred the use of wine, but if Akbar ordered him a cup, he could hit a smaller mark. A cup, a full quart, was brought him, which he drank off, and then, firing, hit the mark, to the applause of all present. Akbar ordered it to be recorded, 'that wine was as necessary to Europeans as water to fish, and to deprive them of it was to rob them of the greatest comfort of their lives.' He then gave permission to foreigners to cultivate vineyards in his dominions. There can be no doubt the vine would flourish well on the tablelands and mountain sides of India, as on the Nilgarry hills, where the temperature and soil are all that can be desired for the purpose."

Dr. Robertson, quoting Arrian in his historical disquisition concerning ancient India, enumerates the articles of commerce between that country and the Western world, from which it appears that that country, even before the age of Mohammed, received supplies of wine from the West, in return for its spices, precious stones, and other products. This commerce, says Dr. Robertson, was extensive and various. He mentions wine among the importations from Egypt at the port of Patala, in the river Indus. Barygaza, which corresponds with the modern Baroach on the Nerbuddah, is another point at which Italian, Greek, and Arabian wines were imported. At Musires, the next emporium of note on the coast, the articles imported were much the same, he says, as at Barygaza, but they are not specified. The exports are enumerated, but, like those from the other Indian ports, include no wine.

From this statement, taken in connexion with those which precede it, there can be no doubt of the consumption of wine in India from the earliest times, while it is equally manifest that its supplies of the article have been mainly drawn from foreign countries.

A species of wine is made from the date fruit produced by a kind of palm tree which grows in India, as well as Arabia, Africa, and other parts of the earth. The tree lives two or three hundred years. The antiquity of this wine is attested by Herodotus, who says that it constituted the principal article of commerce of Babylonia, and that the Egyptians knew of it, and used it in embalming. The people of India also make wine from the liquor contained in the cocoa nut, which they call tari, and also arrak.

PERSIA.

Persia, in its greatest extent in ancient times, embraced all that vast region which lies between the Indus and Oxus on the East and Northeast, and the Euphrates on the West, and reached from the Caspian Sea and Mount Caucacus on the North to the Persian Gulf and Indian Ocean on the South. But its power has long been on the decline, and its god Terminus has receded from time to time, until the present limits of the kingdom are comparatively narrow.

As has been elsewhere said, the Persians claim to have been the inventors of wine. They discovered the art of making it in a way perfectly natural, and yet unexpected. One of their earliest kings, Jemsheed, who, if we credit their annals, was only five or six generations from Noah, was the fortunate discoverer. "He was immoderately fond of grapes," says the narrative, which is found in Sir John Malcolm's History of Persia, "and desired to preserve some, which were placed in a large vessel and lodged in a vault for future use. When the vessel was opened the grapes had fermented ; their juice in this state was so acid that the king believed it must be poisonous. He had some vessels filled with it, and poison written upon each ; these were placed in his room. It happened that one of his favorite ladies was affected with nervous headache ; the pain distracted her so much that she desired death. Observing a vessel with poison written on it, she took it and swallowed its contents. The wine, for such it had become, overpowered the lady, who fell down into a sound sleep, and awoke much refreshed. Delighted with the remedy, she repeated the doses so often that the monarch's poison was all drunk. He soon discovered this, and forced the lady to confess what she had done. A quantity of wine was made, and Jemsheed and all his court drank of the new beverage, which, from the circumstance that led to its discovery, is to this day known in Persia by the name of *zeher-e-khoosh*, or the delightful poison."

Persia has in all ages been famed for the excellence of its grapes, and the authority of the Koran itself has not been sufficient to eradicate from an ignorant and superstitious race the love of the superior wines made from them. In the sacred book of Mohammed it is said, page 39, Sale's London edition, 1801 : "They will ask thee concerning wine and lots, (games of chance.) Answer. In both there is great sin, and also some things of use unto men ; but their sinfulness is greater than their use." Mr. Sale, in his Preliminary Discourse, presents some interesting comments upon this subject : "The drinking of wine," says he, "under which name all strong and inebriating liquors are comprehended, is forbidden in the Koran in more places than one. Some, indeed, have imagined that excess therein is only forbidden, and that the moderate use of wine is allowed by two passages in the same book ; but the more received opinion is, that to drink any strong liquors, either in a lesser quantity or in a greater, is absolutely unlawful ; and, though libertines indulge themselves in the contrary practice, the more conscientious are so strict, especially if they have performed the pilgrimage to Mecca, that they hold it unlawful not only to taste wine, but to press grapes for the making of it, to buy or to sell it, or even to maintain themselves with the money arising by the sale of that liquor. The Persians, however, as well as the Turks, are very fond of wine ; and if one asks them how it comes to pass that they venture to drink it, when it is so directly forbidden by their religion, they answer that it is with them as with the Christians, whose religion prohibits drunkenness." * * *

"Several stories have been told as to the occasion of Mohammed's prohibiting the drinking of wine ; but the true reasons are given in the Koran, viz : because the ill qualities of that liquor surpass its good ones, the common effects thereof being quarrels and disturbances in company, and neglect, or, at least, indecencies in the performance of religious duties. For these reasons it was that the priests were, by the Levitical law, forbidden to drink wine or strong drink when they entered the tabernacle ; and that the Nazarites and Rechabites, and many pious persons among the Jews and primitive Christians, wholly abstained therefrom ; nay, some of the latter went so far as to condemn the use of wine as sinful. But Mohammed is said to have had a nearer example than any of these in the more devout persons of his own tribe."

It seems but fair to give Mohammed the credit of assigning his real motives in the prohibition of the use of wine and strong drink ; for, at most, he erred on the side of virtue. But it is alleged by Dr. Paley and other philosophical writers, that abstinence from intoxicating liquors in the climate of Medina, where the false prophet lived, was an easy virtue, and that he compensated his followers for the denial of a luxury to which they were not naturally prone by allowing very great latitude in the intercourse of the sexes. When Mohammedanism extended itself into regions of the earth where the use of wine and other intoxicating liquors had taken deep root, the rigid precepts of the Koran gave way before the inveterate appetites and habits of the people.

Malcolm, whose work has already been quoted, gives other interesting facts and anecdotes

illustrative of the Persian love of wine : "The Persians of all conditions," says he, "are fond of society. Their table is in general well furnished, as the extraordinary cheapness of provisions of every kind, and the great plenty of fruit, enable the lowest order of citizens to live well. The hog is the only animal whose flesh they are positively forbidden to eat. They are also, as Mohammedans, prohibited from tasting wine; but this rule is often broken; and, as to use their own phrase, 'there is equal sin in a glass as in a flagon,' they usually, when they drink, indulge to excess. They are, indeed, so impressed with the idea that the sole pleasure of this forbidden liquor is centred in its intoxicating effects, that nothing but constant observation can satisfy them that Christians are not all drunkards. 'It is,' they often remark, when speaking to a person of that persuasion, 'one of the privileges of your religion to be so, and therefore neither attended with shame nor disgrace.' An English officer belonging to a frigate had come on shore at Abushehcr, and mounted a high spirited horse to take a ride.) The awkwardness of the rider, who was nearly falling at every bound the animal took, amused a great number of spectators. Next day a Persian who supplied the vessel with fruit and vegetables came off, and seeing the officer, said to him, 'I have saved your reputation; not a man of those who laughed at you yesterday has the least suspicion that you are a bad horseman.' 'How have you managed that?' said the gentleman he addressed. 'I told them,' he replied, 'that you, like every Englishman, rode admirably, as became a nation of soldiers, but that you were very drunk, and that alone was the reason of your not keeping your seat upon the saddle so firmly as you otherwise would have done.'" The historian remarks: "If an endeavor is made to remove these impressions by telling them that, though we are permitted to use wine, excess is always considered as degrading, and often, when it incapacitates for duty, as criminal, they listen with a smile of incredulity; for they believe it impossible that men who are not withheld by motives of a religious nature can deny themselves what they are led by the restraint imposed upon them to deem one of the most delightful of all enjoyments."

The grapes of Persia are said to be among the finest in the world; "some of which," says Redding, "are a fair mouthful." "Yet the white wine of Ispahan," he continues, "is made from a small white grape called Kismish, which has no pips, perhaps first brought from the island of that name, noted for fine fruits, near Gombron. The grape of the province of Cashbin is celebrated; it is called Shahoni, 'the royal grape,' and is golden colored and transparent. The grapes are kept over the winter, and remain on the vine a good deal of the time in linen bags." "It is in Farsistan or Ferdistan," the same writer says, "upon the lowest slope in the mountains, not far from Shiraz, that the largest grapes in Persia are grown, though the imperial grape of Taurus is most extolled for eating and the table, being more delicately luscious. The whole country near Shiraz is covered with vineyards. The best red wine is made from a grape named Damas; it is said to be of good strength and body, and to keep well for fourscore years, preserving all its virtues in the highest perfection. This wine is put into flasks of glass, called carabas, of about thirty quarts, covered with plaited straw, and packed in chests of ten bottles each. In this way it is sent to Teheran, Bassora, the East Indies, and wherever it is exported."

"There are twelve kinds of grapes grown near Shiraz. Some species are violet, others red, and even black in color, as the Samarcand grape. A single bunch will weigh a dozen pounds. They sell their wine by weight, and keep it either in flasks or jars of well-glazed earth. Their cellars are strong, and built with great attention to coolness, water being often introduced for this purpose. Seats are frequently provided in them for visiters to enjoy the wine in greater luxury, although forbidden by the Mohammedan law."

"Of the quantity of wine grown at Shiraz," says Redding, "it is not easy to form an estimate. Tavernier states that when he travelled, (about the middle of the seventeenth century,) between four and five thousand tuns were made annually." It is not at all probable, owing to the general decline of Persia in power and civilization, that so much is made at the present day. The grapes are well trodden in a vat, the bottom of which is perforated to permit the escape of the must into a vessel below. From the latter it is transferred to glazed jars, which are deposited in the cellar, where fermentation takes place. It is afterwards strained and put in bottles for sale. There are several varieties of the Shiraz wine, which have in all ages been in high repute. They were the favorite drink of the Mahommedan emperors of India, at the period of their power, and they have long been known in Europe. Redding describes the *vin de liqueur* of Shiraz as remarkably sweet and luscious, and full of strength and perfume. The king of Persia at one time sent a present of wine to the sovereign of England. It was of the celebrated white variety, though some in that country is of a dark amber color, while other kinds are red, resembling Bordeaux in appearance. The white is said to resemble Madeira, though unequal to the latter.

Persia has a considerable population which is not Mohammedan. There are Jews, Armenian Christians, and Guebers or fire-worshippers; while the Mohammedans themselves are divided into a number of sects. The result is that nearly one-half of society has no scruple about the use of wine, and the other half scarcely feels the necessity of disguise.

The vines in Persia, says Mr. Morier, are trained on the walls until they overleap them, and hang down on the other side. It is only necessary to water them at Shiraz once a year, about the 10th of April.

The celebrated traveller, Marco Polo, met with boiled wines on the confines of Persia. He attributes this peculiarity to the effort to evade the letter of the Koran, as the effect of the boiling was to change the name of the liquid. But the same custom, as we have seen, prevails in China. It was also practiced by the ancient Greeks.

"Teheran, Yezd, Shamaki, Gilan, and Ispahan," says Redding, "are the principal wine districts in Persia known to strangers. In Mingrelia, the ancient Colchis, the soil is bad, but the wines are characterized as excellent. Georgia sends its wines to Azarbazan and Ispahan. At Tiflis wine is sold openly. Wine tolerably good is made in Chorasan. The Turks, both in Persia and the neighboring countries, when they take the forbidden draught, laugh at Christians for mingling water with it; and yet if they but spill a single drop upon their own garments, however valuable they may be, they immediately throw them away as polluted. The Turks always intoxicate themselves: hence the wine manufacturers in Mohammedan countries add stimulating and intoxicating ingredients to the wines made for secret sale to the children of the Koran. Of late years the manufacture of wine, even at Shiraz, has been neglected, and it is much to be feared the produce of the still has taken its place with the Mohammedans in their covert oblations to Bacchus."

Tavernier says that Shah Abbas II. was much addicted to wine, but did not on that account neglect his affairs. His successors, however, loved wine and women to great excess, and became exceedingly cruel in consequence.

Malte Brun, in his Universal Geography, says that "the most esteemed fruits of Europe are believed to have been brought originally from Persia, as the fig, the pomegranate, the mulberry, the almond, the peach, and the apricot. The oranges are of enormous size, and are found in places sheltered by the mountains. The heat reflected from the sand is particularly favorable to the cultivation of the lemon. The vine displays here all its riches, but is only cultivated by the Guebers, or the worshippers of fire. There are, among other kinds of wine, three particularly excellent. That of Shiraz, reputed to be the best, is kept for the use of the sovereign and the grandees of the court. That of Yezd is very delicate, and is transported to Laur and Ormus. That of Ispahan is distinguished for its delicious sweetness."

Of the countries between India and Persia, and especially Cabool, an English traveller, Lieut. Alex. Burnes, who visited it in 1831, gives, in his highly interesting work entitled "Travels in Bokhara," a glowing picture. He describes Cabool as a terrestrial paradise, abounding in gardens in which every fruit that can please the eye or tempt the appetite grows in the richest profusion. The city is situated 6,000 feet above the level of the sea, and claims an antiquity of as many years.

"Cabool is particularly celebrated for its fruit, which is exported in great abundance to India. Its vines are so plentiful that the grapes are given for three months of the year to cattle. There are ten different kinds of these. The best grow on frame-works; for those which are allowed to creep on the ground are inferior. They are pruned in the beginning of May. The wine of Cabool has a flavor not unlike Madeira, and it cannot be doubted that a very superior description might be produced in this country with a little care. The people of Cabool convert the grape into more uses than in most other countries. They use its juice in roasting meat, and during meals have grape powder as a pickle. This is procured by pounding the grapes before they get ripe, after drying them. It looks like cayenne pepper, and has a pleasant acid taste. They also dry many of them as raisins, and use much grape syrup. A pound of grapes sells for a half penny."

In his travels through Bokhara the author scarcely alludes to the vine; and from the general decay and dilapidation which he depicts, it is probable that no attention is given to it.

Of the Punjaub, in general, he says that the productions of the vegetable world exceed the consumption of the population, and increase in abundance toward the hills; and that most of the vines and fruit trees of Europe may be seen in Kishtwar and Cashmere.

TURKEY IN ASIA.

Modern Turkey embraces within its limits several countries, which, in the course of ages, have separately constituted great empires or kingdoms. It includes the seats of the ancient Assyrian and Babylonian empires, and that of the Macedonian empire, as well as of the Greek empire, which succeeded it; it still claims sovereignty over Egypt, together with Palestine, Arabia, Mesopotamia, and Asia Minor. The history of the grape and of wine making in Egypt has already been traced, with brief allusions to that of Armenia and other districts in that portion of the Turkish dominions; but in regard to these latter countries further facts will be given in connexion with Asia Minor.

The Bible abounds in allusions to the vine and to wine, and perhaps no other single object furnishes so many occasions for figurative illustration in the sacred writings as the vine and its fruit. The ancients had a proverbial saying that a region yielding corn, wine, oil, and salt, was a favored land ; and in this respect Palestine was peculiarly blessed. The valley of Eshcol has been famous since the time of Moses for the abundance as well as the wonderful size of its grapes. The messengers sent by him, while he and his people were yet in the wilderness, to spy out the promised land, returned with a bunch which two men carried between them upon a staff. He had commanded them to "see the land, what it is," "whether it be fat or lean," and to "bring of the fruit of the land," for "now the time was the time of the first ripe grapes. * * * And they came unto the brook of Eshcol, and cut down from thence a branch with one cluster of grapes, and they bare it between two upon a staff; and they brought of the pomegranates and of the figs. The place was called the brook Eshcol, because of the cluster of grapes which the children of Israel cut down from thence."—(Numbers, chap. xiii.)

Jacob, on his death-bed, when pronouncing a prophetic benediction upon his twelve sons, said to Judah, "Judah is a lion's whelp," "and unto him shall the gathering of the people be. Binding his foal unto the vine, and his ass's colt unto the choice vine, he washed his garments in wine and his clothes in the blood of grapes. His eyes shall be red with wine, and his teeth white with milk." These strong figures are understood not as intended to imply drunkenness and excess in the descendants of Judah, so much as the abundance of the land they were to inherit. Calmet, the learned expositor of the Bible, thinks that the vine here referred to is a superior kind named Sorek in the original. "Rabbi Isaac Ben Geuth," he says, "thinks these grapes were of a kind which has no seeds, and etymology favors the idea, for in Arabic the word signifies, among other things, to emasculate, to deprive, as if these grapes were deprived of their seeds. These fruits, however, have generally a transparent, membraneous seed, though some are said to have actually no seed at all, whereby, while they are chewed, no seed is discoverable to the taste or tongue, yet it is apparent when the grape is cut with a knife and seed is sought for." Calmet quotes from Le Bruyn a passage in which he describes similar grapes without seed in Persia.

In regard to the grapes of Eshcol, Calmet says: "It is certain that we must not judge of the Eastern vines by our own, and that the grapes of Judea are at this day of great size; but the language of Scripture and of Nature does not satisfy Jewish Rabbins. They insist that this bunch of grapes was so large and so heavy that it required eight men to carry it, of which each sustained the weight of three hundred and sixty pounds. Wagenseil cites also the Talmudists as saying, 'Then whoever could procure one of the grapes was obliged to carry it away in a cart or in a boat; and after having placed it in a corner of his house, he might tap it and draw out wine for family consumption, as out of a cask ; the wood which the stalk furnished he might use to dress his victuals. There was not a single grape but yielded thirty hogsheads of wine.' " The grave and learned Benedictine is justly offended at this extravagance in professed commentators upon the Bible.

"There were in Palestine," says the same learned author, "many excellent vineyards. Scripture celebrates the vines of Sorek, of Lebanah, of Jazer, of Abel. Profane authors mention the excellent wines of Gaza, Sarepta, Libanus, Saron, Ascalon, and Tyre. * * But when the spouse in the Canticles, i, 14, compares her beloved to a cluster of cypress that grew in the vineyards of En-gedi," he says : "These vineyards of En-gedi were not vineyards of grapes for wine only, but of plants of cypress."

The children of Israel are often in Scripture compared to the vine which God had brought out of Egypt and planted in Palestine, but which, instead of bringing forth good fruit, produced only bitter fruit and wild grapes. The parables of the Saviour, in which he compares the kingdom of heaven to a householder who planted a vineyard and let it out to tenants, and again compares himself to the true vine and his disciples to the branches, are familiar to every one.

"The law of Moses," says Calmet, "did not allow that whoever planted a vine should eat of its fruit before the fifth year. They also did not gather their grapes on the seventh year ; the fruit was then left for the poor, the orphan, and the stranger. A traveller was allowed to gather and eat grapes in a vineyard as he passed along, but he was not permitted to carry any away. It was also forbidden to sow anything else in a vineyard.

Of the wild vine, Labrusca, Calmet says that "it grew without culture near the highways and hedges. Its fruit was a very small grape, which became black when ripe, but often it did not ripen at all." This account of the wild grape of Palestine would suffice in every particular for the wild grape in the United States.

Calmet, in another place, gives some interesting facts in regard to the grapes of Eshcol which may be introduced here. "Travellers," says he, "mention some growing there of a prodigious size. Doubdan assures us that in the valley of Eshcol were bunches of grapes of

24——A

ten and twelve pounds. Forster tells us he was informed by a religious, who had lived many years in Palestine, that there were bunches of grapes in the valley of Hebron so large that two men could scarce carry one of them." Dr. Adam Clark saw a bunch that weighed twenty pounds.

Of the vintage, Calmet observes that this season was accompanied with feasts and great rejoicings. Isaiah says, (xxv, 6,) "In this mountain shall the Lord of Hosts make unto all people a feast of fat things, a feast of wines on the lees, of fat things full of marrow, of wines on the lees well refined." Literally, a feast of fatness, a feast of lees, of marrowy fatness, of clarified lees. And Isaiah, xvi, 10: "Gladness is taken away, and joy out of the plentiful field; and in the vineyards there shall be no singing, neither shall there be shouting: the treaders shall tread out no wine in their presses; I have made their vintage shouting to cease." Carmel signifies an excellent vineyard. And Jeremiah says, (xlviii, 33,) "Joy and gladness is taken from the plentiful field [from the Carmel] and from the land of Moab, [which was fruitful in vines,] and I have caused wine to fail from the wine-presses: none shall tread with shouting, their shouting shall be no shouting." Hebrew literally, they shall no longer tread the grape; and he that cries hedad shall no more cry *hedad! hedad!* The last term is the cry of the vintagers, whence is formed *heth* and *de heth* (huzza! bravo!) with vigor, with courage, cheerfully.

To recur to the antediluvian period, Calmet says: "Several of the ancients were of opinion that wine was not in use before the deluge, and that Noah was the first who introduced this liquor. If wine, say they, had been known before the flood, Abel would have made an offering of it to the Lord, and Noah would have been on his guard against drinking it to excess. Others maintain that it is much more probable the first men had the use of wine, which is a liquor so generally useful and agreeable that it could not be unknown even to Adam. Jesus Christ tells us that the first men were surprised by the deluge while they were eating and drinking, which is commonly understood of such as drink wine. We may say that though Noah knew the intoxicating quality of wine, yet he might think that the quantity he drank of it was not capable of causing the drunkenness in him that he afterwards found.

"Hardly any sacrifices were made to the Lord, but they were accompanied by libations of wine."—(See Exodus xxix, 40; Numbers xv, 5, 7.)

"The use of wine was forbidden to the priests during the time they were in the tabernacle, and employed in the service of the altar; (Lev. x, 9.) This liquor was also forbidden to the Nazarites, (Num. vi, 3,) and whenever wine was forbidden, all other intoxicating liquors were understood to be forbidden also. The Rechabites observed a strict abstinence from wine, in pursuance of the commands they had received from their father Rechab.—(Jer. xxxv.) In the style of the sacred penmen the wine, or the cup, often represents the anger of God: 'Thou hast made us drink the wine of astonishment.'—(Psalm lx, 3.) 'In the hand of the Lord there is a cup, and the wine is red; it is full of mixture; and he poureth out of the same; but the dregs thereof, all the wicked of the earth shall wring them out and drink them.'—(Psalm lxxv, 8.) The Lord says to Jeremiah, (xxv, 15,) 'Take the wine-cup of this fury at my hand, and cause all the nations, to whom I send thee, to drink it.'

"Wine was administered medically to all who were in trouble or sorrow. Proverbs xxxi, 4, 5, and 6: 'Give strong drink unto him that is ready to perish, and wine unto those that be of heavy hearts.' The Rabbins tell us (Tract. Sanhedr.) that they used to give wine and strong liquors to those who were condemned to die, at their execution, to stupefy them, and to take off some part of the fear and sense of their pain. There were certain charitable women at Jerusalem, they tell us, who used to mix certain drugs in wine, to make it stronger and more capable of abating the sense of pain. It is thought such a kind of mixture was that offered to Jesus Christ to drink before he was fastened to the cross. Mark xv, 23: 'And they gave him to drink wine mingled with myrrh; but he received it not.'

"Ezekiel, xvii, 18, speaks of a kind of excellent wine sold at the fairs of Tyre. He calls it fat wine—Hebrew, wine of Helbon. This wine was well known to the ancients; they called it Chalibonium vinum. It was made at Damascus. The Persians had planted vineyards there on purpose, says Posidonius, quoted by Athenæus. This author says that the Kings of Persia used no other wine for their common drink.

"Hosea, xiv, 7, speaks of the wine of Libanus; 'the scent thereof shall be as the wine of Lebanon.' The wines of those sides of Mount Libanus that had a good aspect were heretofore much esteemed. They commend that of Biblos; and even to this day the wines of Libanus are in repute. But some think that wine of Libanus may signify a sweet-scented wine, in which perfumes are mixed, or drugs, to give it a better flavor. Odoriferous wines were not unknown to the Hebrews. In Canticles viii, 2, mention is made of a medicated wine, *vinum conditum*, wine mixed with perfumes. The Book of Wisdom, ii, 7, notices a precious sort of wine, which probably was perfumed; 'let us fill ourselves with costly wines and ointments.' Nectar was also a wine of the same nature. The wines of Palestine being heavy, they used to qualify them with water, that they might be drank without inconve-

nience. Proverbs ix, 2, 5: 'She hath mingled her wine: she hath also furnished her table. Come, eat of my bread, and drink of the wine which I have mingled.' And Psalms lxxv, 8: 'In the hand of the Lord there is a cup, and the wine is red; it is full of mixture.' The priests of Bel said to the King of Babylon, (Bel, ii,) 'Sir, do you mingle the wine yourself, and set the meat upon the altar of Bel.' Revelations xviii, 6: 'In the cup which she hath filled, fill to her double.' Fulgentius says, in the second book of his Mythologies, 'that the wine of Sarepta, a city of Phœnicia, was so strong that the greatest drinkers could hardly drink above a pint of it.' Calmet thinks it likely 'that this mingling of wines is rather two kinds of wine mingled together, to improve their flavor, as rough with smooth, over-sweet wine with other of a weaker relish,' &c. Those who sat long over wine were too good judges to admit of water as an improvement. The cup full of mixture probably means some of the lees, to be drank off to the very dregs; as they did not keep their wine bottled, but in larger quantities, so, when they drew it off, some mixture might accompany the clear liquor.

"Wine of astonishment (Psalms lx, 3) may represent the cup of God's anger, with which he inebriates the wicked, or rather, according to the Hebrew, the cup of the wine of affliction impregnated with its lees. It might also be translated wine of trembling, that produces death, that poisons, that stupefies.—(Psalms lxxv, 8.) The Septuagint translate it wine that stings inwardly—that causes affliction or compunction; Aquila, wine of stupefaction; Symmachus, wine of agitation or disturbance.

"Wine of the palm tree, called in the Vulgate *sicera*, (Deuteronomy xiv, 26, and *passim*,) is made of the sap of the palm tree. It is common in the East.

"Wine of libation (Deuteronomy xxxii, 38; Esther xiv, 17) was the most excellent wine, poured on the victims in the temple of the Lord, or pure wine, because in libations they used no mixtures.

"The wicked 'eat the bread of wickedness and drink the wine of violence.'—(Proverbs iv, 17.) They are maintained by ill-gotten goods, or they abuse the good things that God gives them; they offend him by their abuse of the comforts of life.

"The wine of uprightness (Canticles i, 3—vii, 9) was good wine—true and excellent wine.

"A feast of wine is that in which wine abounds, or a banquet of solemnity—a banquet of invitation; for usually they drank no wine at their ordinary meals.—(Isaiah xxii, 13—xxiv, 9, 11.)

"The wine of the condemned (Amos ii, 8) may be understood of the wine given to condemned criminals.—(Proverbs xxxi, 6.) Diodorus Siculus, lib. 1, page 62, speaks of a wine in Egypt to dispel sorrow and appease anger. Homer says in Egypt Helen learned the composition of *Nepenthe*, which procures forgetfulness of evils. But another interpretation may be given to this passage of Amos ii, 8: they drink the wine; they make themselves merry at the expense of those whom they have unjustly condemned. The Septuagint says they drink wine earned by their slanders; the Chaldee, the wine of rapine [of mulcts—fines.]

"New wine, which is not to be put in old bottles, (Matthew ix, 17; Mark ii, 22; Luke v, 37,) the Holy Ghost, with which the apostles were to be replenished after our Saviour's ascension."

The first miracle of the Saviour was to convert water into wine at Cana in Galilee; and at his last supper with his disciples he enjoined its use in a perpetual sacrament.

"In a figurative sense a vintager is taken for one who ravages a country or carries on a bloody war in it. The prophets use this metaphor to express the vengeance which the Lord takes on his enemies. 'Thou hast planted thy people as a vine, and now all that pass by partake of the vintage.'—(Psalms lxxx, 12.) And in Lamentations i, 15: 'The Lord hath trodden the virgin, the daughter of Judah, as in a wine press.' Isaiah, lxiii, speaking of a conqueror returning from a great expedition, having his clothes all besmeared with blood, describes him thus: 'Who is this that cometh from Edom, with dyed garments from Bozrah?—this that is glorious in his apparel, travelling in the greatness of his strength? I that speak in righteousness, mighty to save. Wherefore art thou red in thine apparel, and thy garments like him that treadeth in the wine-fat? I have trodden the wine-press [of fury, wrath, &c.] alone, and of the people there was none with me.'"

Modern travellers concur in describing the excellence and abundance of the grapes of Palestine, where there is the least care taken in their culture. Dr. Barclay, in his "City of the Great King," has given a "Calendar of the vegetable kingdom for Jerusalem and the surrounding country," from which are taken the following extracts in relation to grapes:

October.—"The grape season is still well maintained."

November.—"The vintage terminates this month. The grapes not heretofore consumed as an article of diet, or converted into raisins, are trodden in the wine-press, and set fermenting in the vat for wine or vinegar. Some of the expressed juice, however, instead of being thus appropriated, is boiled down to the consistence of molasses, under the name of dibs, or dibes, and is far superior to any kind of sugar-cane treacle. The raisins, as well as figs, are rather indifferently cured, and are mainly consigned to the still by the Jews and Christians,

and converted into arrak and alcohol of no mean bead; but great quantities of them are consumed as a cheap and wholesome article of diet. Although Ichabod is evidently written upon Eshcol, yet it still produces most delicious grapes, particularly a seedless species, very much sought after by housekeepers. The vines are generally permitted to lie upon the ground in a state of the utmost neglect, without the slightest bracing or training; but in some of the vineyards of Eshcol a bracing is most effectually accomplished by tying together the tops of three or four neighboring vines."

June.—"Olives, almonds, figs; a few grapes ripe also."

July.—"Abundant supply of pears, nectarines, peaches, grapes, melons, &c."

August.—"All the fruits and vegetables of this goodly land are now mature. Figs, grapes, citrons, and pomegranates still abound."

September.—"Grapes, olives, pomegranates, &c."

The grape-gathering season continues a month or two longer; but, by the end of this month, the earth having made an abundant return of all her varied productions, refuses all assistance from man, and makes the rains a *sine qua non* to further effort."

The vine flourishes in all parts of Asia Minor. Wilkinson, in his "Tour," &c., makes frequent mention of fine vineyards, and occasionally of good wine. In the vicinity of Marsiwan the vineyards are numerous, from which a good red wine is made. The wine produced in the neighborhood of Amasia is highly praised, but the travellers were denied the use of it in consequence of the great drought which prevailed, the Turks denying themselves and everybody else the luxury of wine until their prayers for rain should be answered. Near Erzeroum, where the Turks are unusually consistent in the disuse and proscription of wine, the article produced was found to be very inferior. Near Tiflis, in Georgia, the hills are described as being "covered with forests of oak, ash, beech. chestnuts, elms, and walnuts encircled with vines growing perfectly wild, but producing vast quantities of grapes. From these is annually made as much wine as is necessary for the yearly consumption. The remainder are left to rot on the vines." Erivan, the capital of Persian Armenia, abounds in vineyards and gardens, and the people of Erivan imagine that their vines are of the same sort as those planted by Noah.

Arabia, notwithstanding its sterility and the unfriendly prejudices and religious ideas of its Mohammedan inhabitants, produces grapes in most of the provinces, and in some of them wine. Niebuhr (Voyage to Arabia) saw excellent fruits, and particularly raisins, at Taaif, in the Province of Hedjas. The Province of Oman, he remarks, affords several different sorts of grapes. "Although the Mohammedans drink no wine," says the author, "the Arabians, however, plant the vine and have a great variety of grapes. They dry a small sort of grape called Kischmisch, which has no stone, but only soft and almost impalpable seeds, and of these grapes they sell a quantity to their neighbors." The Arabians are observers rather of the letter than the spirit of the law, and while they abstain from wine they have no scruple about producing intoxication by other means. "As they have no strong drink," says Niebuhr, "they, for this purpose, smoke Haschisch, which is the dried leaves of a sort of hemp. This smoke exalts their courage and throws them into a state in which delightful visions dance before the imagination. One of our Arabian servants, after smoking Haschisch, met with four soldiers in the street and attacked the whole party. One of the soldiers gave him a sound beating and brought him home to us. Notwithstanding this mishap he would not make himself easy, but still imagined, such was the effect of his intoxication, that he was a match for any four men." Dr. Henderson (History of Wines) thinks that the Arabians discovered the art of distillation, which, he says, was not known to the ancients.

The Assyrians were familiar with the use of wine in the earliest ages, of which the completest evidence exists in the Bible, as well as in the recent discoveries of Mr. Layard at Nineveh and Babylon. Daniel and his companions, Hananiah, Mishael, and Azariah, who were selected from among the captives taken from the Jews by Nebuchadnezzar to be educated at the court, had wine, among other luxuries, sent them from the King's table. "And the King appointed them a daily provision of the King's meat, and of the wine which he drank: so nourishing them three years, that at the end thereof they might stand before the King."—(Chap. I, v. 5.) * * "But Daniel purposed in his heart that he would not defile himself with the portion of the King's meat, nor with the wine which he drank," v. 8. "Belshazzar, the King, made a great feast to a thousand of his lords, and drank wine before the thousand. Belshazzar, while he tasted the wine, commanded to bring the golden and silver vessels which his father Nebuchadnezzar had taken out of the temple which was in Jerusalem, that the King and his princes, his wives and his concubines, might drink therein."—(Chap. V, v. 1, 2.) * * "They drank wine, and praised the gods of gold, and of silver, of brass, of iron, of wood, and of stone," v. 4.

The Assyrian monarchs gave entertainments on the most magnificent scale, in which wine was always profusely served. Nabuchodonosor, on his return from a victorious expedition against Arphaxad, feasted with his whole army for one hundred and twenty days; and

similar accounts are given of the feast with which Sardanapalus entertained his army, and the princes and generals of his Empire, after his great victory over the Medes. The book of Esther relates that Ahasuerus, who "reigned from India even unto Ethiopia," "made a feast unto all his princes and his servants, the power of Persia and Media, the nobles and princes of the provinces being before him, when he showed the riches of his glorious kingdom, and the honor of his excellent Majesty many days, even an hundred and fourscore days." "And they gave them drink in vessels of gold, (the vessels being diverse one from another,) and royal wine in abundance, according to the state of the King. And the drinking was according to the law; none did compel: for so the King had appointed to all the officers of his house that they should do according to every man's pleasure." "On the seventh day, when the heart of the King was merry with wine," &c. (Chap. I.) * * * "And the King said unto Esther at the banquet of wine, What is thy petition? and it shall be granted thee: and what is thy request? even to the half of the kingdom, it shall be performed." (Chap. V.) * * "And the King arising from the banquet of wine in his wrath, went into the palace garden: and Haman stood up to make request for his life to Esther the queen," &c. (Chap. VII.)

These graphic and beautiful touches of the sacred penman convey at once an idea of ancient manners, while they serve the purpose for which they are here quoted. Mr. Layard, whose discoveries have entitled him to speak with an unusual degree of authority on this subject, says that on these festive occasions "wine was served in abundance, and women, including even the wives and concubines of the monarch, were frequently present to add to the magnificence of the scene." "Wine was drank immoderately. When Babylon was taken by the Persians, the inhabitants were celebrating one of their great festivals, and even the guards were intoxicated. The Babylonian King, ignorant of the approaching fate of his capital, and surrounded by one thousand of his princes and nobles and by his wives and concubines, drank out of the golden vessels that had been carried away from the Jewish temple. On the walls of the palace at Khorsabad was a bas-relief representing a public feast, probably in celebration of a victory. Men were seen seated on high chairs, with drinking cups in their hands, whilst attendants were bringing in bowls, goblets and various fruits and viands for the banquet. At Nimroud part of a similar bas-relief was discovered."

The same author remarks that, "When Herodotus says that the Assyrians did not cultivate the vine, the olive, or the fig, he must allude to the inhabitants of the plains. The vine is represented in the sculptures; and that the Assyrians not only enjoyed the various luxuries which those trees afford, but possessed the trees themselves we learn from their own general, Rabshakeh, who described his country to the Jews as a 'land of corn and wine, a land of bread and vineyards, a land of olive-oil and honey.' Among the objects of tribute brought to the Egyptians from the Tahai and from Naharaina are corn, bread, palm wine, wine, honey, incense and conserve of dates."

Among many highly interesting articles found at Nimroud by Mr. Layard, during his second expedition, was "a metal wine-strainer of elegant shape."

These historical facts and recent discoveries among the ruins of Nineveh and Babylon leave no doubt that the ancient Assyrians were not only familiar with the use, but with the production of wine. For centuries past these ancient seats of civilization have been the prey of the Arabs of the desert, and in many places almost every vestige of cultivation has ceased. The vine may not have flourished in the immediate neighborhood of the great cities Nineveh and Babylon, which were situated in the low valleys of the Tigris and the Euphrates; but we have the testimony of modern travellers that the adjacent hills and higher lands within the Assyrian empire produce an abundance of grapes at the present day. Wilkinson, already quoted, says that Mosul is supplied with grapes, raisins, wine, and various fruits from the province of Kurdistan, which was a part of the ancient Assyria. And he relates that in descending the Tigris, between Mosul and Bagdad, ancient Babylon, the party were supplied by boatmen on shore "with a large quantity of fine grapes, melons and cucumbers." Mr. Layard, in his second expedition to Nineveh and Babylon, frequently met with the vine in the country above the former and within a short distance of it. At Beblis, which may be a hundred miles above the ruins of Nineveh, he describes the mountain sides as affording "scenery, landscapes, gardens, poplar trees, and low white houses surrounded by trellised vines." Still nearer the ruins, at a feast given to his party by a Yezidi chieftain, he says: "After we had eaten of stuffed lambs, pillaws and savory dishes, and most luscious grapes, the produce of the district, our entertainer placed a present of home-made carpets at our feet, and we rose to depart."

"On the mountain of Tmolus, in Lydia," says Henderson, "a brown, sweet wine was produced, which is classed by Virgil and Galen among the first-rate growths, but described by Pliny as too luscious to be drank by itself, and as chiefly used for flavoring and correcting the harshness of other wines. The Scybeltites, so called from the place of its growth in Galatia, is only noticed by Galen on account of its thickness and extreme sweetness. The

Abates, which was a wine of Cilicia, appears from his report to have been a sweetish wine of a red color. The Tibenum, Arsynium, and Titucazenum are enumerated by the same author among the lighter growths of his native country, (Mysia;) the two first were probably dry red wines; the latter is described as a sweet wine, but not very rich or high colored. They ripened the soonest of all the Asiatic wines.

GREECE AND EUROPEAN TURKEY.

It has already been remarked that the Greeks attributed the invention of wine to Bacchus. That mythical personage is reported to have travelled over the greater part of the globe, introducing the vine and the art of wine-making. But it has been elsewhere shown, from high classical authority, that the Grecian god of wine was taken at third hands from India, through Egypt. Several festivals were observed in honor of this god, in which the most monstrous excesses were committed. Human sacrifices were offered to him at one of these, and at others drunkenness and debauchery were deemed the most acceptable service. One of the festivals to Bacchus was instituted with a view to secure his interposition for the preservation of wine against the westerly winds, which were deemed unfavorable in their influence; and such wines as remained unchanged by these periodical winds were pronounced likely to keep well.

"Among the Greek wines," says Dr. Henderson,* "the earliest of which we have any distinct account is the Maronean, probably the production of the territory of that name on the coast of Thrace, or of Ismarus, near the mouth of the Hebrus, where Ulysses received the supply which he carried with him on his voyage to the land of the Cyclops. It was a black, sweet wine; and, from the evident delight with which Homer enlarges on its virtues, we may presume it to have been of the choicest quality. He describes it as 'rich, unadulterate, and fit drink for the gods,' and so potent that it was usually mixed with twenty measures of water:

"'And even then the beaker breathed abroad
A scent celestial, which whoever smelt
Thenceforth no pleasure found it to abstain.'

"Pliny mentions the growths of Maronea as being in high favor in his time. Other parts of Thrace were famous for their wines, but Ismarus seems to have longest maintained its credit. The black wine of Sciathos, mentioned by one of the poets, must have been of a much lighter quality, as it was drunk with an equal measure of water.

"Pramnian, which was a red but not a sweet wine, appears to have been of equal antiquity; for we find Hecumede, under the direction of Nestor, preparing a copious draught of it for Machaon, when he received the wound in his shoulder. According to certain writers the Pramnian was derived from the island Icarus, where there was a rocky hill of that name; others describe it as the growth of Ephesus, or Lesbos; while some, again, suppose that the appellation was intended to express its durable quality." Henderson compares it to Port wine. It seems not to have been popular with the Athenians, for Aristophanes tells us "that they disliked those poets who dealt in the rough and horrible as much as they abominated the harsh Pramnian wine, which shrivelled the features and obstructed the digestive organs. But the Corinthian wine, according to the testimony of Alexis, far exceeded the Pramnian, and to drink it was actual torture.

"It was in the luscious, sweet wines that the Greeks surpassed all other nations; and to to this class the commendations of their later poets must be regarded as chiefly applying. They were, for the most part, the products of the islands of the Ionian and Egean seas, where the cultivation of the vine was assiduously practiced, and where the finest climates and the choicest soils and exposures gave to its fruit an uncommon degree of excellence. Lesbos, Chios, and Thasos, in particular, seem each to have contended for the superiority of its growths; but several of the other islands, such as Corcyra, Cyprus, Crete, Cnidus, and Rhodes yielded wines which were much esteemed for their sweetness and delicacy; and it was from them that the greater part of Europe was supplied, till a comparatively recent period, with the richest sweet wines." These wines were not white, but of a straw or amber color, according to their greater or less age. This hue they would derive from being fermented with the skins of the grapes, which, says the author, were used in their ripest state,

* "History of Ancient and Modern Wines." This is perhaps the most complete work on the subject ever published; and yet it is far from covering the whole field. His account of ancient wines is almost exclusively confined to those of Greece and Rome; and by far the largest portion of his work is devoted rather to the processes of cultivating the vine and manufacturing the wine than to the history and statistics of their cultivation and use. The object of this paper is to present the subject in this latter point of view, and the appropriate limits assigned to it exclude the idea of going into the details of vine dressing, of soils, of climates, and of the fermentation and preservation of wines. But these matters have been frequently treated in the Annual Reports of the Patent Office, and will be hereafter; and hence the omission of all special allusion to them here will, doubtless, be rather acceptable to the general reader than otherwise.

or after they had become partially dried, and, being generally of the Muscat sort, would impart a grateful perfume to the liquor—a quality on which the Greeks placed a due value, as may be seen from the frequent allusions to it by their poets. "The exquisite aroma of the Saprian was probably Chian wine matured by great age. The Lesbian would seem to have been less odorous, but to have possessed a delicious flavor, for it is said to have deserved the name of Ambrosia rather than of wine, and to have been like nectar when old." Horace styled the Lesbian "an innocent wine." Pliny places the growths of Chios and Thasos before the Lesbian, which he affirmed had naturally a saltish taste; but the Clazomenian, which came from the coast of Ionia, and which was less adulterated with sea-water, is said to have been preferred to all the others on account of its purer flavor. The Thasian was a generous, sweet wine, ripening slowly, and acquiring by age a delicate odor of the apple. The Chian, again, is by some writers described as a thick, luscious wine; and that which grew on the craggy heights of Ariusium, extending three hundred stadia along the coast, is extolled by Strabo as the best of all Greek wines. From Athenæus we learn the produce of the Ariusian vineyards was usually divided into three distinct species—a dry wine, a sweetish wine, and a third sort of a peculiar quality." "All of them seem to have been excellent of their kind, and they are frequently alluded to in terms of the highest commendation. The Phanean, which is extolled by Virgil as the king of wines, was also the product of the same island. The wines of Naxos, Rhodes, and Cos, on the other hand, were still more liable to the censure passed on the Lesbian in Pliny's time; and those of Zante and Leucadia had the character of being heady; as the latter were prepared with gypsum, they were probably of a drier nature and more potent quality than the wines of the other islands.

"Among the lighter kinds, the Mendean, which most likely took its name from Mende, a town in Thrace, was a white wine, and of such moderate strength that it bore dilution in only three parts of water." "The Argitis, celebrated by Virgil for its extraordinary durability, and procured from a small grape abounding in juice, is also believed to have been a white wine." "A light, rough wine, named Omphacites, was procured in Lesbos and Thasos from a particular species of grape, which was gathered before it had attained its full maturity, and exposed to the sun three or four days previous to pressure."

"The above are all the principal wines of Greece to which it is possible to assign distinctive characters. But, besides these indigenous growths, the Greeks were familiar with the produce of the African and Asiatic vines, of which several enjoyed a high reputation, and may be considered as the parent stocks from which the first Grecian vineyards were supplied. According to Florentinus, some of the Bythinian wines, but especially that produced from a species of grape called Mersites, were of the choicest quality; the wines of Byblos, in Phœnicia, on the other hand, vied in fragrancy with the Lesbian; and, if we may confide in the report of Athenaeus, the white wines of Mareotis and Taenia, in Lower Egypt, were of almost unrivalled excellence."

The reader will have been struck with the singular statements in the foregoing in regard to the necessity of mixing water with the wine of the ancient Greeks, in the proportions of two, and even of twenty, to one. The same fact will be noted in the accounts to be herein given of the Roman wines. It seems that what was called wine among those nations was often rather a syrup than the liquid beverage with which we are familiar in modern times. This was particularly the case with the stronger kinds, which required a large admixture of water. The ancient wines were reduced to this degree of consistency by the process of "smoking" to which they were subjected. For this purpose a furnace, or drying kiln, called by the Romans the fumarium, was made a necessary appendage to every wine-cellar. The amphorae, or vessels of six and three-fourth gallons, were placed over this heating apparatus. "One certain consequence," says Henderson, "of the long exposure of amphorae to the influence of the fumarium must have been that a portion of the contents would exhale, and that the residue would acquire a greater or less degree of consistence; for, however well the vases might have been coated and lined, (with pitch, mastic, oil, &c.,) or however carefully they might have been closed, yet, from the nature of the materials employed in their composition, from the action of the vinous fluid from within, and the effect of the smoke and heat from without, it was quite impossible that some degree of exudation should not take place. As the more volatile parts of the must were often evaporated by boiling, and as various solid or viscid ingredients were added to the wine previous to its introduction into the amphorae, it is manifest that a further exhalation must have reduced it to the state of a syrup or extract. In the case of the finer wines, it is true, this effect would be in some measure counteracted by the influence of the insensible fermentation; and a large proportion of the original extractive matter, as well as of the heterogeneous substances suspended with it, would be precipitated on the sides and bottom of the vessels in the form of lees; but in other instances the process of inspissation would go on without much abatement from this cause. Hence it comes that so many of the ancient wines have been described as thick and fat, and that they were not deemed ripe for use until they had acquired an oily smoothness from age. Hence, too, the practice of employing strainers *(cola vinaria)* to clarify

them, and free them from their dregs. In fact, they often became consolidated to such a degree that they could no longer be poured from the vessels, and it was necessary to dissolve them in hot water before they could be drunk. We learn from Aristotle that some of the stronger wines, such as the Arcadian, were reduced to a concrete mass when exposed in skins to the action of smoke; and the wine-vases discovered among the ruins of Herculaneum and Pompeii have generally been found to contain a quantity of earthy matter. It is clear, then, that those wines which were designed for long keeping could not have been subjected to the highest temperature of the fumarium without being almost always reduced to an extract. Indeed, Columella warns the operator that such might be the issue of the process, and recommends that there should be a loft above the apotheca, into which the wines could be removed."

The same author says that "the application of the fumarium to the mellowing of wines was borrowed (by the Greeks) from the Asiatics, who were in the habit of exposing their wines to the heat of the sun on the tops of their houses, and afterward placing them in apartments warmed from below, in order that they might be more speedily rendered fit for use."

"Although Tibullus gave the epithet 'smoky' to the Falernian wines thus prepared, and Horace speaks of the amphorae, with which he proposed to celebrate the Kalends of March, as having been laid up 'to imbibe the smoke' during the consulship of Tullus, they are not to be understood as alluding to the flavor of the liquor, but merely to the process by which it was brought to a high degree of mellowness. The description of Ovid, however, may be considered as more correct; for he applies the term only to the cask in which the wine was enclosed." "As these forced wines were in great request at Rome and in the provinces, the dealers would often be tempted to send indifferent specimens into the market; and it is not, perhaps, without reason that Martial inveighs so bitterly against the produce of the fumaria of Marseilles, particularly those of one Menna, who seems to have been a notorious offender in this line, and whom the poet humorously supposes to have abstained from revisiting Rome lest he should be compelled to drink his own wines."

In further illustration of this peculiarity of ancient wines, a few more passages may be cited: "Amphictyon is reported to have issued a law," says Henderson, "directing that pure wine should be merely tasted at the entertainments of the Athenians; but that they should be allowed to drink freely of wine mixed with water, after dedicating the first cup to Jupiter the Saviour, to remind them of the salubrious quality of the latter fluid. However much this excellent rule may have been occasionally transgressed, it is certain that the prevailing practice of the Greeks was to drink their wines in a diluted state." "To drink wine unmixed was held disreputable, and those who were guilty of such excess were said to act like Scythians. To drink even equal parts of wine and water was thought to be unsafe, and, in general, the dilution was more considerable, varying, according to the taste of the drinkers and the strength of the liquor, from one part of wine and four of water to two of wine and four or else five of water, which last seems to have been the favorite mixture. From the account which Homer gives of the dilution of the Maronean wine with twenty measures of water, and from a passage in one of the books ascribed to Hippocrates, directing not less than twenty-five parts of water to be added to one part of old Thasian wine, some persons have inferred that these wines have possessed a degree of strength far surpassing any of the liquors with which we are acquainted in modern times, or of which we can well form an idea. But it must be remembered that the wines in question were not only inspissated, but also highly seasoned with various aromatic ingredients, and had often contracted a repulsive bitterness from age, which rendered them unfit for use until they were diffused in a large quantity of water. If they had equalled the purest alcohol in strength, such a lowering as that above described must have been more than enough, but the strong heterogeneous taste which they had acquired would render further dilution advisable; and, in fact, they may be said to have been used merely for the purpose of giving a flavor to the water. In the instance cited from Hippocrates's works, the mixture with Thasian wine is prescribed for a patient in fever, and can therefore be regarded as nothing more than a mild diluent drink."

The water used in dissolving the inspissated wines was sometimes purified by boiling, and when the solution was completed the liquor was strained through a cloth in order to free it from impurities. The liquor thus obtained must have been far inferior to the modern wines, although enthusiastic admirers of the ancients have professed to think otherwise. The wines of the ancients were frequently drunk warm, and hot water was regarded as indispensable at their entertainments. Lucian describes a supper at which wine and water, hot and cold, were placed on a side table for the accommodation of the guests.

The ancients were familiar with a great many varieties of the vine. About fifty are enumerated by Roman authors. Of ancient wines, Henderson gives a catalogue containing seventy-eight kinds. Greece abounded in vineyards, upon which great attention was bestowed, and their productiveness was wonderful. They were acquainted with the best

methods of cultivating the vine, and of manufacturing wine. There are few arts which have made so little progress as these in the course of ages. Many of the maxims and customs relating to vine-dressing and wine-making have been handed down from generation to generation for two thousand years in Greece and Italy, and are now in vogue in those countries. But it will ever be thought singular that the tastes of the ancients should have become so perverted as to give a preference to wines to which sea water, pitch, rosin, or turpentine had been added. After all, however, these additions to the juice of the grape, in order to improve its flavor, are not more contrary to reason and to the unsophisticated tastes of men than are many of the customs of modern times, which seem to be based on absurd and capricious fancy, and to defy the dictates of nature. Of this character is the use of tobacco, which, in all its forms, is eminently repulsive to the natural appetite. "With respect to the admixture of salt water and resinous gums," says Henderson, "it may be observed that both these articles are still commonly used for the preparation of wines in modern Greece." Turpentine, in some one of its forms, it is alleged, is also used in the composition of gin.

The ancient wines were divided into two chief classes, the sweet and the dry; and into a third, both sweet and dry, or sweetish. The wine presented to persons of distinction was of the rich sweet kind, "of which," says Henderson, "Ulysses had twelve amphorae given him by Maron, and which was so highly valued by the donor that he kept it carefully concealed from all his household save his wife and the intendant of its stores, as its attractions were not easily resisted."

The more generous wines were never used before the fifth year, and the majority of them were kept much longer. The thin white wines were said to ripen soonest.

On this branch of the subject a modern writer has brought together, in a pleasing form, a variety of information as to the quality of ancient wines, as well as their use in the convivial entertainments of the Athenians. "The travels of Anacharsis the younger in Greece, during the middle of the fourth century, before the Christian era," is the work of a French scholar, the Abbé Barthélemy, but every statement in regard to the manners, customs, institutions, and history of the people is supported by references to Greek authors. It is therefore as authentic as any direct quotation from ancient authors, and has the additional advantage of bringing together the scattered fragmentary allusions to every subject of which he treats. The imaginary traveller, while at Athens, was invited to sup with a wealthy citizen named Dinias, in company with several of his friends. The more substantial parts of the entertainment, which resembled a modern dinner rather than a supper, will be omitted, and the quotation commenced with what relates to the use of wine on the occasion. The physician, Nicocles, has "the floor;" and, after giving his opinion on other matters, commences descanting upon the subject of wines and liquors, as follows:

"'All liquors, in like manner, have their properties. Wine is dry and heating, and has something purgative in its nature; sweet wines fly to the head, the red are nourishing, the white aperient; clarets dry and favorable to digestion. Hippocrates tells us that new wines are more laxative than old, as they approach nearer to the nature of must; aromatics are more nutritive than others; your red, mellow wines'——

"Nicocles was continuing his dissertation, but Dinias, suddenly interrupting him, exclaimed, 'I pay no attention to such distinctions, but I banish from my table the wines of Zacynthus and of Leucas, because I believe them to be unwholesome, on account of the plaster that is mixed with them. I do not like that of Corinth, for it is harsh; nor that of Icaria, because, in addition to this fault, it is heady. I esteem the old wine of Corcyra, which is exceedingly pleasant, and the white wine of Mende, remarkable for its delicacy. Archilochus compared that of Naxos to nectar, but I should compare the wine of Thasos to that divine liquor. I prefer it to every kind of wine except that of Chios, when of the first quality; for there are three sorts of it.

"'In Greece we are fond of sweet and odoriferous wines. In some places they sweeten them by putting flour kneaded with honey into the cask; and almost everywhere origanum, aromatics, fruits, and flowers are infused in them. My pleasure is, on opening one of my barrels, to have the odor of violets and roses instantly exhale and fill my cellar; not that I would wish to have one sense too much gratified at the expense of another. The wine of Byblos, in Phœnicia, surprises at first by the strength of the perfumes with which it is impregnated. I have a good stock of it; yet I hold it greatly inferior to that of Lesbos, which, though less highly scented, is infinitely more grateful to the palate. Do you wish for an agreeable and wholesome beverage? Mix your fragrant and rich wines with those of an opposite quality; such is the mixture of the wine of Erythrae with that of Heraclea.

"'Sea water mixed with wine is said to aid digestion and prevent the wine from flying to the head; but it must not be too predominant, which is the fault of the Rhodian wines—a fault which is avoided in those of Cos. I believe one measure of sea water is sufficient for fifty of wine, especially if, in preparing it, the new methods are adopted in preference to the old.

" 'Learned researches have taught us to mix our liquors with exactness. The usual proportion of wine with water is as two to five, or as one to three, but with our friends we choose rather to reverse this proportion, and toward the end of the entertainment to forget all these austere rules.

" 'Solon prohibited the use of pure wine. Of all his laws this is perhaps the most religiously observed, thanks to the perfidy of our merchants, who weaken this precious liquor. As for myself, I import my own wine, and you may rely upon it that the law of Solon will be uniformly violated during the whole of this entertainment.'

"As he ended these words Dinias sent for several bottles which had been kept ten years, and which were soon followed by others still older.

"We now drank about almost without interruption. Demochares, after giving several toasts, took up a lyre, and whilst he was tuning it, entertained us with an account of the custom of intermixing songs with the pleasures of the table. 'Formerly, said he, 'all the guests sang together, and in unison; but afterwards it became the established rule for each person to sing in his turn, holding a branch of myrtle or laurel in his hands. The mirth was less tumultuous, indeed, but ceased to be very lively; and it was still further restrained when the lyre was introduced to accompany the voice, for then several of the guests were absolutely reduced to silence. Themistocles was formerly reproached, with justice, for having neglected to acquire skill in this pleasing art; in our time Epaminondas has been much commended for having cultivated it. But when too great a value is set on such accomplishments, they become a study; the art attains perfection at the expense of pleasure and hilarity, and success is only attended with a smile.

" 'Convivial songs at first contained only expressions of gratitude, or lessons of wisdom. We then celebrated in them, as we do still, the gods, heroes and citizens, who had benefitted their country. To subjects of so grave a nature were added, in process of time, the praises of wine; and poetry, employed to depict its pleasing effects in the most lively colors, painted at the same time that confusion of ideas, those tumultuous emotions which we experience with our friends at the sight of the liquor sparkling in the cups. Hence, all those bacchanalian songs, interspersed with maxims, sometimes relative to happiness and virtue, and sometimes to love and friendship. For it is to these two sentiments that the soul delights continually to recur when overpowered with an excess of joy.' "

But the moralist soon forgot himself in his cups, and his disobedient lyre rejected all noble themes, and reserved its notes for the songster of wine and love.

Ages of bondage and misgovernment have had their accustomed effects in effacing almost all trace of the high civilization which Greece once enjoyed, and have left that lovely land in a condition only a little removed from barbarism. Agriculture has deteriorated no less than the other arts of life; yet, since it is beyond the power of man to extinguish the powers of nature, the soil and climate of modern Greece still attest their admirable adaptation to the production of the vine. The rule, or rather the misrule of the Turks, has been peculiarly unfavorable to the culture of the vine, since misgovernment and superstition under their fatal sway have conspired for its destruction. "Wherever the Turkish arms have penetrated," says Henderson, "desolation has followed in their train. Lands which, in former times, yielded the richest harvests have been suffered to run to waste; whole districts have been abandoned; and the wretched inhabitants who remain, enjoying no security of person or property, often being forced to contribute one-seventh of their crop to a government which is constantly harassing and oppressing them, can look forward to little improvement in their circumstances by increased exertion; and are, therefore, generally content to snatch, by a hasty and imperfect cultivation of the soil, the few productions required for their immediate subsistence." Such was the condition of Greece for centuries prior to the period at which Henderson wrote. But since the revolution by which the Turkish tyrants were expelled, the Greeks have enjoyed a government of their own, and great meliorations and improvements have taken place. "While under the Venetian republic," says the same author, "Candia and Cyprus supplied the whole of Europe with the finest dessert wines; and so abundant was their produce, that, toward the end of the sixteenth century, the former island alone, if we may credit Bacci, sent annually to the shores of the Adriatic not less than two hundred thousand casks of Malmsey. Since it has experienced the miseries attendant on Turkish sway, the Greek population has gradually diminished; the manufacture of wine has been confined to a few districts; and the quantity procured is insufficient to meet the wants of the inhabitants. When Mr. Drummond travelled, the average amount of the exportation of Cyprus was estimated at 365,000 cuse, or 973,333 gallons, and the total produce of the wine harvest at 800,000 cuse, or 2,133,333 gallons. About fifteen years ago (that is, in 1809) the quantity exported was reduced to 65,000 cuse, and the supply of common red and white wines for internal consumption was only about as much more. Such is the change effected by the government of the Captain Pacha, in whom the property of this fine island is now vested."

The soil and climate of Greece are highly favorable to the vine. Nothing but a more

skilful cultivation is wanting, says Henderson, to produce wines equal to those of the Hermitage or Madeira. This admirable adaptation to the vine is not peculiar to any part of Greece. Both the continent and the islands seem to possess every requisite for this culture. "The red wine of Ithaca," a traveller observes, "is excellent, superior to that of Tenedos, the Greek wine which it most resembles; but it is generally much injured, sometimes spoiled, by the injudicious manner in which it is kept. In the possession and management of the British commandants at Cephalonia and Ithaca, we found it a delightful wine, with a Hermitage flavor and a good sound body." The best Greek wines are said to be now, as formerly, of the luscious sweet class. "Those made in Cyprus and Tenos," says Henderson, "the red Muscadine of Tenedos, and the white Muscadine of Smyrna, vie with the richest Hungarian wines. Several of the islands, however, as Ithaca, Cephalonia, Candia and Cyprus, yield abundance of dry, red wines, which resemble the secondary growths of the Rhone, and which, with a little more care in the manufacture, might be rendered fit for general exportation. Even now a considerable quantity is sent to the ports of the Black sea. The red wine of Corfu is distinguished by its lightness and delicacy. In the island of Zante a wine is made from a Corinth grape, which is said to approach to Tokay.

"Candia and Cyprus alone, if properly cultivated, would be capable of supplying us with every variety of wine. In the former island the vineyards of Kissanos yielded an agreeable claret; while those of Rethymo gave a fine flavored white wine, which keeps very well; and the Malmsey made by the Caloyers of Canea, and on the hills adjacent to Mount Ida, has been long in high estimation. In Cyprus the domain called the Commandaria, from its having belonged to the knights of Malta, affords the choicest sweet wine." "The white Muscadine of Cyprus is also an excellent dessert wine, but has generally a disagreeable taste of the tar or pitch used for coating the bags in which it is conveyed from the mountains. According to Olivier, however, the white wine of Santorini, known under the name of Vino Santo, ranks before the best growths of Cyprus. It is principally exported to Russia."

The vineyards most in esteem at Scio, according to Tournefort, are those of Mesta, whence the ancients had their nectar. Mesta is the capital of the famous quarter called by the ancients Ariousia.

Continental Greece abounds in the finest situations for vineyards on the slopes of the calcareous mountains, but the peasantry are tempted to plant their vines in the lowlands, in order to secure a larger product, though inferior in kind, for less labor. The vintage is collected carelessly, and the manufacture of the wine is on the rudest plan. The result is that it rarely keeps a twelve-month; and the Greeks, during the summer months, rarely drink anything better than vinegar.

"In some parts of Macedonia," says Henderson, "very tolerable vines are met with. Here are several towns which have long flourished by their overland traffic with Germany; and many of the inhabitants, having long resided in that country, have introduced a better mode of making wine, and the use of subterraneous cellars. The climate of the greater part of Macedonia, it may be observed, is colder than any other southward of the Alps, and therefore between this province and the Archipelago, we should undoubtedly find abundance of sites capable of producing every variety of wines to be found in France and Spain. The Morea no longer affords any but the worst quality, although it is the original country of the Malvasia or Malmsey grape, from which the sweet wines of Madeira, Malaga, and other places, derive their name."

Sir J. C. Hobhouse, who travelled in Albania and other provinces of Turkey in Europe, in the years 1809–'10, everywhere met with the grape and an inferior sort of wine manufactured by the rude inhabitants of those fine regions. Grapes were offered him at almost every meal in the vintage season, and wine was a common beverage. "Near Arta," he says, "we met long strings of horses loaded with goat-skins full of wine, for it was about the middle of the vintage. We observed that the hairy side of the skin was turned inward, and this circumstance accounted for the unpleasant strong savour of the goat in the new wine. Passing a little further, we saw them treading out the liquor in tubs by the hedge side, over which the persons employed in gathering were emptying out the grapes from small wicker baskets." In the vicinity of Zitza he stopped at a monastery. "The Prior of the monastery," he says, "a humble, meek-mannered man, entertained us in a warm chamber with grapes, and a pleasant white wine, not trodden out, as he told us, by the feet, but pressed from the grape by the hand; and we were so well pleased with everything about us that we agreed to lodge with him when we returned from the Vizier." "Each of the skins, (of the goat,) by a very simple process, is so sewed together as to hold and preserve the new wine which in the villages is never put into any other bottles, and seldom lasts beyond the next vintage. Wine of a year old is mentioned as a rarity. That which is made in quantities, and kept in casks, in Joanina, or other large towns, is mixed with pine, resin and lime, weakened with water. The Greeks consider that the resin gives the strength which the water takes away, and that the lime refines the liquor; but it is to this process that a very unpalatable harshness, generally to be met with in Greek wine, is to be attributed.

ITALY AND SICILY.

Henderson believed that in the early ages of the Republic the ancient Romans were little accustomed to the use of wine; but the citations he makes from their laws regulating their religious rites would seem to support the contrary idea. Numa forbade the sprinkling the funeral pile with wine, and Romulus directed milk to be used for libations to the gods. These regulations may have been suggested by the scarcity of wine, as Pliny thought, or by the prevalent idea of religious duty. Sacrifices, both Jewish and heathen, were, as a general rule, commanded to be made of the best and most precious productions of the earth, and of the firstlings of the flocks and herds; while such animals as had any defect or blemish were expressly excluded from the sacrificial altar. To forbid the use of the most precious and costly liquor in libations and sprinklings, and to command the substitution of one of the cheapest, would therefore seem to be wholly inconsistent with the idea of paying homage to the Deity, as well as with what we know of ancient rites and customs. The very fact that wine was forbidden shows that it was known to the Romans in the earliest period of their history; and that it was the product of their own vineyards is next to certain, from the fact that they had no commerce with, and perhaps no knowledge of, any people beyond the confines of Italy; if indeed their acquaintance with the world was not confined to the tribes whose territories bounded Latium.

"That the vine, however, was partially cultivated in those times," says Henderson, "may be inferred from the fact of Mezentius, King of Hetruria, having been paid in wine for the succor which he afforded the Rutilians in their war against the inhabitants of Latium. It was not until the six hundredth year of the city, if the assertion of the author just quoted [Pliny] be correct, that the Italian wines came into such vogue as to be deemed superior to those of all other countries."

"Few parts of Italy proved unfriendly to the vine, but it flourished most in that portion of the Southwestern coast to which, from its extraordinary fertility and delightful climate, the name of Campania Felix was given." "From this district, then, the Romans obtained those vintages which they valued so highly, and of which the fame extended to all parts of the world. In ancient times, indeed, the hills by which the surface is diversified seem to have formed one continued vineyard; and every care was taken to maintain the choice quality of the produce. With respect to the locality and designation of particular celebrated spots much controversy has arisen among critics. In the quotation from Florus which has been adduced, Falernus is spoken of as a mountain, and Martial describes it under the same title; but Pliny, Polybius, and others denominate it a field or territory (ager;) and, as the best growths were styled indiscriminately Massicum and Falernum, Peregrini concurs with Vibius in deciding that Massicus was the proper appellation of the hills which rose from the Falernian plane. By a similar mode of reasoning it might be inferred from the term 'arvis,' which occurs in conjunction with 'Massicus,' in the splendid description of the origin of the Falernian vineyards given by Silius Italicus, that the epithet 'Massicus' was applicable to the more level grounds." The following translation will be preferred to the original:

——— "When the rising sun dispersed the dew,
The Massic swains, with admiration view
Their fields with vines like groves most richly crowned,
And with the sun the branches shining: round
The hill their glory spread, and since that hour
Rich Tmolus and Arvisian cups that pour
Ambrosian liquor forth, and thy fair field,
Fertile Methymna, to Falernus yield."

Englished by T. Ross, 1661.

"The truth seems to be that the choicest wines were produced on the Southern declivities of the range of hills which commence in the neighborhood of the ancient Sinuessa, and extend to a considerable distance inland, and which may have taken their general name from the town or district of Falernum; but the most conspicuous, or the best exposed, among them may have been the Massicus; and as in process of time several inferior growths were confounded under the common denomination of Falernian, correct writers would choose that epithet which most accurately denoted the finest vintages. If, however, it be allowable to appeal to the analogy of modern names, the question as to the locality will be quickly decided; for the mountain that rises from the Rocca di Mendragone, which is generally allowed to point to the site of the ancient Sinuessa, is still known by the name of Monte Massico. That the Massic wines were grown here is sufficiently proved by the testimony of Martial, who describes them as the produce of the Sinuessan vineyards."

"The account which Pliny has furnished of the wines of the Campania is the most circum-

stantial, and, as no one had greater opportunities of becoming familiar with the principal growths of his native country, doubtless the most correct. 'Augustus and most of the leading men of his time,' he informs us, 'gave the preference to the Setine wine that was grown in the vineyards above the Forum Appii, as being of all kinds the least apt to injure the stomach. Formerly the Cecuban, which came from the poplar marshes of Amycla, was most esteemed; but it has now lost its repute, partly from the negligence of the growers, and partly from the limited extent of the vineyard, which has been nearly destroyed by the navigable canal that was begun by Nero, from Avernus to Ostia. The second rank used to be assigned to the growths of the Falernian territory, and among them chiefly to the Faustianum. The territory of Falernum begins from the Campanian bridge, on the left hand as you go to Urbana, which has been recently colonized, and placed under the jurisdiction of Capua by Sylla; the Faustian vineyards, again, are situated about four miles from the village, in the vicinity of Cediae, which village is six miles from Sinuessa. The wines produced on this soil owe their celebrity to the great care and attention bestowed on the manufacture; but latterly they have somewhat degenerated from their original excellence, in consequence of the rapacity of the farmers, who are usually more intent upon the quantity than the quality of their vintages. They continue, however, in the greatest estimation, and are, perhaps, the strongest of all wines, as they burn when approached by a flame. They are of three kinds, namely, the dry, the sweet, and the light Falernian. Some persons class them somewhat differently, giving the name of Gauranum to the wine made on the tops of the hills of Faustianum which is obtained in the middle region, and reserving the appellation of Falernian for the lowest growths. It is worthy of remark that none of the grapes which yield these wines are at all pleasant to the taste.'—(Pliny, Hist. Nat. XIV, 6.)

"With respect to the first of the above-mentioned wines, it is surprising that, notwithstanding the high commendation of Augustus, the Setinum is never once mentioned by Horace, although he has expatiated with all the fervor of an amateur on the other first-rate growths of his time. Perhaps he took the liberty of differing from the imperial taste in this particular, as the Setine was a delicate, light wine, and he seems to have had a predilection for such as were distinguished by their strength. Both Martial and Juvenal, however, make frequent mention of it; and Silius Italicus declares it to have been so choice as to be reserved for Bacchus himself. Galen commends it for its innocuous qualities. It was grown on the heights of Sezza, and, though not a strong wine, possessed sufficient firmness and permanency to undergo the operation of the *fumarium*." "The Cecuban, on the other hand, is described by Galen as a generous, durable wine, but apt to affect the head, and ripening only after a long term of years. In another place he remarks that the Bithynian white wine, when very old, passed with the Romans for Cecuban; but that in this state it was generally bitter and unfit for drinking. From this analogy we may conclude that, when new, it belonged to the class of rough sweet wines. It appears to have been one of Horace's favorite wines, of which he speaks, in general, as reserved for important festivals. After the breaking up of the principal vineyards which supplied it, this wine would necessarily become very scarce and valuable; and such persons as were fortunate enough to possess any that dated from the Opimian vintage, would preserve it with extraordinary care. In fact, we are told by Pliny in a subsequent book that it was no longer grown, and he also alludes to the Setine wine as an article of great rarity. The Fundanum, which was the produce of the same territory, if, indeed, it was a distinct wine, seems to have partaken of the same characters, being, according to Galen's report, strong and full-bodied, and so heady that it could only be drunk in small quantity. There can be little doubt that the excellence of these wines is to be attributed chiefly to the loose, volcanic soils on which they were produced. Much also depended on the mode of culture; and I am inclined to think that the great superiority of the growths of the Falernian vineyards was, in the first instance, owing to the wines being there trained on *juga*, or low frames formed of poles, instead of being raised on poplars, as was the case in several of the adjacent territories."

"There are," says Galen, "two sorts of Falernian—the dry and the sweetish, which latter is produced only when the wind continues in the South during the vintage, and from the same cause it is also of a deeper hue; but in other circumstances the wine obtained is dry and of a yellowish color."

"No wine," says Henderson, "has ever acquired such extensive celebrity as the Falernian, or more truly merited the name of immortal, which Martial has conferred upon it. At least of all ancient wines it is the one most generally known in modern times; for, while other eminent growths are overlooked or forgotten, few readers will be found who have not formed some acquaintance with the Falernian, and its fame must descend to the latest ages along with the works of those mighty masters of the lyre who have sung its praises. But, although the name is thus familiar to every one, scarcely any attempt has been made to determine the exact nature and properties of the liquor; and little more is understood con-

cerning it than that the ancients valued it highly, kept it until it became very old, and produced it only when they wished to regale their dearest friends."

Dr. Henderson undertakes, from the various hints given in ancient writers, to form an opinion of the character of the Falernian wine, and comes to the conclusion : "Among our present wines I have no hesitation in fixing upon those of Xeres and Madeira as the two to which the Falernian offers the most distinct features of resemblance."

"The Surrentine wines, which were the produce of the Aminean grapes, were, in like manner, of very durable quality, and, on account of their lightness and wholesomeness, were much commended for the use of convalescents. They are stated by Pliny to have been grown only in vineyards, and consequently the vines which yielded them could not have been high trained. Their exemption from the fault of bitterness, which most of the other wines acquired by long keeping, has been stated; but Athenæus, upon the authority of Galen, observes that they always remained thin and weak, and never ripened thoroughly from the want of sufficient body. In their early state they appear to have been very harsh and sharp to the taste; and Tiberius used to allege that the physicians had conspired to raise their fame, but that in his opinion they only merited the name of generous vinegar." In these respects they may be compared to some of the secondary growths of the Rhine, which, though liable at first to the imputation of much acidity, will keep a long time, and continue to improve to a certain extent, but never attain the oily smoothness that characterizes the first-rate wines. The wine of Capua resembled the Surrentine.

"Such were the wines of the Campania Felix and adjacent hills, of which most frequent mention is made, and concerning which the fullest particulars have been transmitted. Respecting certain other growths, as the Calenum, Caulinum, and Statanum, our information is of a more imperfect nature. We only know that the vintages of Cales are much praised by Horace, and described by Galen as lighter and more grateful to the stomach than the Falernian; while those of the latter territories are pronounced to have been little, if at all, inferior to that celebrated wine.

"As the soils of the Campania of Rome partake of the same nature, and present many excellent exposures for the vine, some good wines were there produced, but none of them equal in quality to those which we have just been reviewing. The Albanum, which grew upon the hills that rise to the South, in view of the city, is ranked by Pliny only as a third-rate wine; but from the frequent commendation of it by Juvenal and Horace, we must suppose it to have been in considerable repute, especially when matured by long keeping. It was sweet and thick when new, but became dry when old, seldom ripening properly before the fifteenth year. The wine of Labici occupied the middle station between the Falernian and the Alban. The Signinum, on the other hand, is said to have been so rough and astringent that it was chiefly used as a medicine. All these were apparently white wines. Among the lighter growths of the Roman territory, the Sabinum, Nomentanum, and Venefranum were the most agreeable. The first seems to have been a thin table wine, of a reddish color, attaining its maturity in seven years. The Nomentan, however, which was also a delicate claret wine, but of a fuller body, is described as coming to perfection in five or six years. The wine of Spoletum, again, which was distinguished by its bright golden color, was light and pleasant.

"In the arrangement of Pliny, a fourth class of wines was formed by the Sicilian vintages. Of these the Mamertinum, which came from the neighborhood of Messina, and is said to have been first introduced at public entertainments by Julius Cæsar, was a light and slightly astringent wine; but the wines of Tauremenium, being of a similar quality, were often substituted for it. The Pollium, or Pollaeum, of Syracuse, which was of the sweet class, is noticed by several authors as a first-rate wine, being the produce of a particular grape called *biblia*, probably so called from the town of Bibliae, in Thrace. Of the wines of the Southwestern part of the island, whence the best growths are now supplied, I have not perceived any mention. It is unnecessary to swell this list by reciting the names of the other wines which grew within the confines of Italy, as they seem to have been all of an inferior order, and little else can be ascertained with respect to them. In spite of the disadvantages of the climate, which we know to have been more severe in ancient than in modern times, the culture of the grape was extended to the foot of the Alps. Pliny comprehends the growths of Caesena, Liguria, and the territory of Verona among the generous wines, and those of Tuscany are noticed by several authors; but we have already seen that the produce of the vineyards to the North of the Campania Felix was, for the most part, of a light and less durable nature than what was obtained from the Southern districts; and we may, therefore, conclude that the wines above alluded to must have belonged to the same class. The Romans, however, were not content with the supply which they derived from their own territory, but sought to increase the variety of their liquors by importing those of the subject-provinces."

"Of the great abundance of wine among the ancient Romans, the liberal supply which Cato, notwithstanding his extreme frugality, prescribes for his servants, may, perhaps,

afford some notion. 'After the vintage is finished,' he says, 'let the family drink the lora during the first three months. In the fourth month the allowance of wine may be one hemina daily, or, altogether, three congii for each individual. In the fifth, sixth, seventh, and eighth months, one sextarius daily, or, in each month, five congii. In the ninth, tenth, eleventh, and twelfth months, three heminae daily—that is, at the rate of one amphorae [nearly seven gallons] in the month. During the Saturnalia and Compitalia the quantity may be increased to a congius in the day. On the whole, we may reckon the annual consumption of each man at eight amphorae; but to the slaves in fetters we must give rather more, in order that they may perform their work. For them we may consider the allowance of ten amphorae [sixty-eight gallons] in the year as by no means immoderate.'"

"This, however, only shows the plenty of the weak, common wines, which, as a beverage, were probably scarcely equal to our table-beer. But the progress of luxury and the extension of commerce led to a similar profusion of the more costly kinds. Thus Varro relates that 'Lucullus, when a boy, never saw Greek wine presented to the guests oftener than once at any of the great entertainments given by his father; but when he returned from his Asiatic expedition he himself distributed upward of a hundred thousand gallon casks. C. Sentius, late prætor, used to say that Chian wine was first introduced into his house as a cordial prescribed to him by his physician. Hortensius left upward of ten thousand casks of it to his heir!'" It is proper to observe that these figures, in connexion with the terms gallon and cask, convey an exaggerated idea of the quantity of wine distributed, and the English bottle, Henderson thinks, should be substituted.

What has been said in regard to the banquets of the Greeks will apply as well to those of the Romans, since the latter borrowed most of their convivial customs from the former.

The anarchy and despotism to which Italy has been subjected for centuries have had their wonted effect in destroying agricultural enterprise, and reducing that fine country from the highest to the lowest point of productiveness. The vine still grows spontaneously on her fruitful soil, and the slightest attention to it is sufficient to secure an abundant supply of grapes. But the modern system of tillage, as well as the modern art of wine-making, is rude and unskilful, and Italy has ceased to make any but the common wines. None, or next to none, is exported. "The vines which attach themselves to the fences or trees which bound his fields," says Henderson, "commonly supply the Italian peasant with a sufficient quantity of wine for his consumption; and the intermediate land is devoted to other crops. Even in those situations where the proprietor is induced to bestow more care on its culture, the vine still appears but a secondary object, being usually trained to pollard elms, poplars, or mulberry trees, with Indian corn or olive trees between the rows. In certain provinces, as in Lombardy, or the Campagna, it is raised on poles or trellises, but still allowed to shoot up to the height of ten or fifteen feet. In the neighborhood of Barletta and Otranto, however, and a few other spots in the Neapolitan kingdom, and in some parts of Piedmont, it is pruned within two or three feet of the ground, according to the more approved practice!"

The ignorant peasants are said to reverse the order of nature by planting their vineyards in the richest lowlands and their corn on the hill sides, which are admirably adapted to the vine. Notwithstanding the unskilful culture of the vine, the great excellence of the climate would still insure a high rank for Italian wines but for the still greater ignorance displayed in the manufacture of wine. But Henderson excepts the Tuscan wines from the general censure cast upon those of Italy.

Redding thinks that England made a great mistake in giving the preference to the wines of Portugal, in her commercial treaties, to the discouragement of those of Italy and other countries. He contends that Italy produces some good wine, as well as much that is bad; and he attributes the little attention and care given to the manufacture of wine to the want of a stimulus from commerce.

"In 1733," says this author, "Florence wine was in all the market lists of imported wines, and to be had in coffee-houses. The price was from sixty to sixty-three shillings per chest."

"In certain instances much care is bestowed upon the vine. In spots among the Appennines the vines are carefully dressed, terrace-fashion; and were they well pruned, and the fruit taken in due maturity and regularly assorted, which it rarely or never is, a vast deal of excellent wine might be made without altering anything essential besides in the present system of vine husbandry. There is good-bodied wine to be procured in Naples for two pence half-penny (English) a bottle, and at Rome and Florence, four pence. In Calabria, so far is the system of high vine-training from being prejudicial to the mere ripening of the grape, as in the North, that they are obliged to shade the vines from the sun, lest in that volcanic territory the grape should become too ripe, shrivel into a raisin, and be only fit for making wine of the thickest and sweetest kind.

"The principal wine grown in Naples is the Lacryma Christi, [tears of Christ,] a sweet or rather luscious wine, which holds a place in the foremost rank of the first class produced by

any country. Very little of the genuine wine is made even in the most favorable years. It is an exceedingly rich variety, of a red color and exquisite flavor. Vino Graeco is a sweet wine from a grape of that name. A white Muscadine wine, of fine color, delicate and rich in perfume, is also made near Vesuvius. At Pausillipo there is a very palatable wine. A good deal of Lacryma Christi, of an inferior quality, grown in various places around Vesuvius, as at Torre del Græco and Novella, is exported as the genuine wine. The best is grown at Galitta." There are other good wines produced in various localities; but, from negligence in the manufacture, they will not keep. Most of the wines of Italy, says Redding, are consumed in Rome. They are generally of the sweet kind, from Tuscany, Naples, and Sicily. The growth of Albano takes the highest rank. On the shores of Lake Garda they make a sweet wine, like Canary, of prime quality, called Vino Santo. It is not extracted from the grapes until Christmas, and is drunk at the following midsummer. "At Castiglionè they have a Vino Santo of a golden color, which is not fit to drink for four years, and then bears some resemblance to Tokay. The vines of Lombardy and Venice are said to return annually eighty-three millions of gallons. But Tuscany is considered the country of the vine in Italy; and so much has the notion been cherished by the natives that 'Corpo di Bacco' is the common oath of the lower classes. * * The luxuriant vines of Tuscany are almost all of the high training, and the wines are made in some places with considerable care. The hill wines only are good; those of the plains are generally poor."

"Savoy and Piedmont," says the same author, "produce red wines of tolerable quality. Those of Montmelian and St. Albero, in Savoy, are among the best in the country, and come from the slopes of Mont Termino and St. John de la Porte. * * The wines of the Genoese territory are of little repute. * * In Sardinia the produce of the vine is very abundant, so that the fruit is frequently left upon the vines for want of vessels to hold the must. The amber-colored wine called Nasco and a red wine named Giro are the most remarkable. There are several sweet and ordinary wines. The wines called Caunonas, Monaco, and Garnaccia are exported to Holland and Russia.

"Elba grows a little red wine of excellent quality. A hundred vines will produce from twelve to fourteen barrels on the average. The older the vine the richer is the wine; some are one hundred and fifty years old. The hermitage of Monte Serrato and the environs grow Moscatello wines. * * The Elbese wines will bear a sea voyage very well; some have been exported to America without injury. They plant their new vineyards in December.

"The Lipari isles have tolerable wines of the ordinary class. Their Malmsey is excellent: that drawn from the volcano Stromboli is held in much esteem, and nearly all exported.

"Sicily produces wine in great abundance; but the same remarks which apply to the bad husbandry and vintage of Italy will apply to this island. The best wines of the province of Mascoli grow on Etna, and are red, being almost the only good red wine of the class in the island. * * Syracuse produces over its mouldering remains a red Muscadine equal to any other in the world, if not superior. * * Messina furnishes much wine for exportation. * * Marsala, when obtained without the admixture of execrable Sicilian brandy, is an agreeable wine, something like Madeira of the second class, and of great body. * * * Augusta produces wine having a strong flavor of violets."

FRANCE.

We have more full and authentic accounts of the present state of the vine-culture and wine-making in France than of any other country, ancient or modern; but, singularly enough, the treatises on the subject give us ampler details of the history of these arts among the ancient Greeks and Romans than in the great wine country of modern times. Dr. Henderson, whose learned and interesting quarto treatise has been so copiously quoted, furnishes a few passing allusions to the introduction of the vine into ancient Gaul, which will be brought together in the following sketch; but he passes over, almost without notice, the ages which have intervened between the decline of ancient, and the rise of modern, civilization. Yet the literature of those centuries is not void of frequent allusion to the interesting theme, and might afford to the curious student a pleasing subject of inquiry. Redding is still more meagre of historical details than Henderson. Such facts as could be found in these and other authorities are here presented.

The cultivation of the vine in France dates back to the palmy days of Roman power—to the age of Cæsar and Augustus According to Strabo, Narbonnese Gaul yielded every kind of fruit that was to be found in Italy; and Pliny and Columella make repeated mention of the vintages of Gaul. Posidonius, who travelled through Gaul, states from personal observation that the territory of Marseilles supplied a portion of the wines in use among the wealthy classes. But in that age the climate of Europe was much colder than at the present day, and the grape seldom matured north of the Cevennes. Eumenius, a writer of the fourth century, alludes to the methods of propagating the vine among the Aquitani, and on

the banks of the Saone, which is believed to correspond with the modern Côté d'Or. It is a highly interesting fact, commented on by Gibbon, that the climate of Europe was meliorated with the progress of agricultural development. Great armies passed safely over the Rhine on the ice two thousand years ago, which would be utterly impossible in modern times, except, perhaps, in winters extraordinarily cold. But no fact more conclusively demonstrates this important change than the progress of the vine Northwardly. The very best wines of France are now produced from grapes grown on its Northern border, where the vine could not live in the age of the Cæsars. But its culture was attempted on the Moselle and Marne at an early period of our era, and with some success.

Though Italy produced the finest wines in the world, the luxurious inhabitants of the imperial city were not satisfied with them, and imported the products of its distant provinces. Gaul and Spain furnished several wines which were highly prized by the Romans. Those of Dauphiny, Marseilles, and Narbonne, were in the highest repute. The most celebrated were produced from a violet-scented grape of Vienne and the Muscat of Languedoc.

"During the Middle Ages," says Henderson, "there seems to have been less difference in the qualities of wine than is now observable, probably because the manufacture was carried on in a slovenly manner, and little pains were taken to meliorate them by long keeping. But the wines produced near Paris, which are now regarded as inferior, were in early times held in greater estimation than those of Champagne and Burgundy, owing, doubtless, to the inferior skill and intelligence of these remoter provinces. In the 'Bataille des Vins,' one of the Fabliaux of the Thirteenth century, in which the different vintages then in repute are described as passing in review before Philip Augustus, the wines of Epernay, Hautvilliers, Sezanne, Tonnere, and Chablis, are particularly specified; those of Ay and Cumières are named for the first time in the poems of Eustace Deschamps, who flourished about two centuries later. When more generally known, the Champagne wines soon rose into high estimation, and became, as Paulmier has observed, the ordinary beverage of kings and princes."

"In 1328," says Redding, "Rheims wine bore a price of ten livres only, while Beaune fetched twenty-eight. In 1559, at the coronation of Francis II, Rheims wines were dearer than Burgundy, but the wines of the Lyonnais carried a still higher price. In 1561 these wines had risen in price. In 1571 they were nearly eight times increased beyond their former value. Champagne reached its present perfection and estimation about 1610, at the coronation of Louis XIII. The oldest anecdote which the French possess relative to the excellence of Rheims wine dates as far back as 1397, when Wencesilaus, King of Bohemia and the Romans, on coming to France to negotiate a treaty with Charles VI, arrived at Rheims, and having tasted the wine of Champagne, it is to be presumed for the first time, spun out his diplomatic errand to the longest possible moment, and then gave up all that was required of him in order to prolong his stay, getting drunk on Champagne daily before dinner. It is said that Francis I, of France, Pope Leo X, Charles V, of Spain, and Henry VIII, of England, had each of them a vineyard at Ay, their own property, and on each vineyard a small house occupied by a superintendent. Thus the genuine article was secured by each sovereign for his own table." In 1387 the wines of Gascony, as well as those of the Rhine, enjoyed great celebrity. "The best sold for twenty shillings per tun, though six years before they were at a hundred shillings." "For a long time," says Henderson, "the choicest growths, not only in France, but in other countries, were raised on lands belonging to the church; and the vinum theologicum was justly held to be superior to all other vines. The rich chapters and monasteries were always more studious of the quality than of the quantity of their vintages; their grounds were tilled with the greatest care, and their vines were managed in the most judicious manner; nor did they reject a plant that bore but sparingly, provided there was no falling off in the goodness of the liquor which it supplied. Moreover, in the Middle Ages it is well known that the clergy were almost the sole depositaries of learning; and the continued opportunities of observation and study which their retired pursuits afforded them had probably brought them acquainted, at a very early period, with the best methods of directing the fermentation of the grape and meliorating the produce. When their domains passed into the hands of laymen, the same assiduity and skill were seldom shown in the culture of the vines or treatment of the vintage; and, in many instances, the old plants, which yielded the most valued wines, were rooted out to make room for others that gave a more abundant supply, but of inferior character. As long as the Clos-Vougiot [containing about eighty acres] remained in possession of the Cistercian abbey its vines gave but small crops of fruit; and the monks were generally content with obtaining from fifteen to twenty hogsheads of the first quality of wine. Since the revolution those vines which were supposed to be four or five centuries old have disappeared, the greater part of the grapes are now mixed together, and about three hundred hogsheads are obtained which, on account of the ancient repute of the vineyard, sell at a high price, but which, when compared with the select vintages of former times, and with some of the present growths of the adjacent territory, can only be regarded as of secondary rank." These remarks upon the degeneracy of French wines must be confined to certain

particular growths, and would convey a wrong impression if taken as referring to the wines of that country generally. The fact is unquestionable that modern science and skill have rendered the wines of the present day far superior to those of any former period, and especially to those produced in the Middle Ages.

The cultivation of the vine in France has made great progress within a period of seventy years, but not without considerable fluctuations. In 1788 there were in vineyards 3,988,800 acres; in 1822, about 4,700,000 acres; in 1829, 5,100,000 acres; in 1845, 4,300,000 acres; in 1853, 4,873,934 acres. The following table, which is derived from the latest commercial authorities, will be found highly interesting, as it shows at a glance the wine products of the several provinces in gallons. It is for the year 1845, and may be taken as an average crop for several years past. The hectolitres are carefully reduced to gallons, at the rate of 26.4 of the latter to one of the former. The calculation can be verified by multiplying 35,962,000 hectolitres, the aggregate, by 26.4 gallons. The aggregate products of the several Provinces with which American readers are more familiar are also given, instead of the Departments of which the Provinces are composed.

French wine crop of 1845.

Provinces.	Gallons.
Champagne	43,586,400
Burgundy	62,594,400
Lorraine	49,024,800
Alsace	24,103,200
Franche Compte	23,020,800
Dauphiné	16,711,200
Provence	68,983,200
Languedoc	144,170,400
Roussillon	7,946,400
Bearn	8,580,000
Auvergne	14,203,200
Limousin	7,260,000
Guienne and Gascony	182,635,200
Lyonnais	25,555,200
Bourbonnais	5,148,000
Angoumois	30,412,800
Saintonge	63,201,600
Foix	4,382,400
Berri	12,223,200
Touraine	16,579,200
Bretagne	15.232,800
Poitou	27,667,200
Nivernois	4,488,000
Anjou	13,464,000
Normandie	554.400
Orléannois	37,831,200
Maine	2,349,600
Isle of France	37,488,000
Total	949,396,800

The average crop of France at the present time is estimated to be worth about $100,000,000, or from ten to twelve and a half cents per gallon. Redding gives a table of the crop in the several Departments, with the value, but omits to give the year. It is, however, one of the more recent. The aggregate in quantity is 35,075,689 hectolitres, or 925,998,189 gallons; and the value 540,389,298 francs. Reduced to dollars, the amount is $100,514,083 42. According to this estimate the average value of the wine is a fraction over ten cents per gallon. This astonishing cheapness of wine in France is explained by the fact that the above aggregate includes the inferior as well as the best qualities, and that the latter bear no proportion to the former in quantity, as will presently be shown. A few small vineyards, sometimes embracing only a few acres, by keeping up a high reputation for generations, are

sufficient to give celebrity to a province; and while the few gallons, or, at most, pipes, may sell at high prices, ninety-nine hundredths of the vintage are classed as ordinary, or inferior, and are sold at the low prices indicated by the above estimate.

The crop of 1849 is given at 925,000,000 gallons; that of 1839 at 810,000,000 gallons. The exports of wine from France bear a small proportion to the product, but include a large proportion of the best qualities. In 1849 the export was 41,000,000 gallons; in 1850 the export was 42,000,000 gallons; in 1851, 49,500,000 gallons; in 1852, 53,200,000 gallons; in 1853, 43,500,000 gallons. The average export is less than one-twentieth of the product. About one-eighth part of the wine crop of France, including the meanest qualities, is distilled into brandy or made into vinegar; and the remainder, ranging from seven to eight hundred million gallons, is consumed by the people, at the rate of about twenty gallons per head for every man, woman and child in the empire. It is gratifying to add that the consumption of brandy is less than half a gallon to the inhabitant! That of England exceeds a gallon.

CHAMPAGNE.

Some account of the product of the several Provinces will now be given; and, as Champagne is the most celebrated for its wines, it will be first in order. The average crop of this Province is about forty or forty-one million gallons. That of 1845, as will be seen in the foregoing table, was 43,586,400 gallons, which are produced upon an area of about 140,000 acres of ground, or 285 gallons to the acre. The Department of Marne produces the famous sparkling Champagne. The average crop given by Redding amounted to 422,487 hectolitres, or 11,152,656 gallons. He values this product at 11,235,297 francs, or about twenty cents per gallon. Low as this price is, it is about double the average value of French wines. About 2,700,000 gallons of the best product of the Department of Marne are annually sent beyond its limits for a market; the residue is distilled or consumed at home. The growths of this Department are divided into river and mountain wines. The former are mostly white, the latter red. It is a great mistake to suppose that all the wines of Champagne are of the white sparkling kind, since this kind is peculiar to a portion of the Department of Marne; while even Marne produces several other excellent wines, white and red. Most of the white or river wines are brisk, and of superior quality to the red or mountain wine. Henderson says that the briskest wines are not always the best; they are the most defective in the vinous quality, and the small portion of alcohol they contain immediately escapes from the froth as it rises on the surface, carrying with it the aroma, and leaving the liquor that remains in the glass nearly vapid. Humboldt has shown that when the froth is collected under a bell-glass surrounded with ice the alcohol becomes condensed on the sides of the vessel by the operation of the cold. "Hence," remarks Henderson, "the still, or the creaming, or slightly sparkling Champagnes are more highly valued by connoisseurs, and fetch higher prices than the full frothing wines." The tendency to effervesce is repressed by icing these wines before they are used. But this precaution is unnecessary when they are kept cool.

"Among the white wines of Champagne," says Henderson, "the first rank is usually assigned to those of Sillery; under which name is comprehended the produce of the vineyards of Verzenay, Mailly, Raumont, &c., situate at the Northeastern termination of the chain of hills that separates the Marne from the Vesle, and belonging formerly to the Marquis of Sillery. It is a dry, still liquor, of a light amber color, with considerable body, and a flavor somewhat analogous to that of the first growths of the Rhine; and, being one of the best fermented Champagne wine, may be drank with the greatest safety." It was long known by the name of Vin de la Maréchale, from having been manufactured with peculiar care by the Maréchale d'Estrées. The number and varieties of Champagne wine, as of the wines of the other provinces, is too great for recital in this place.

BURGUNDY.

A ridiculous controversy is said to have arisen in the French schools in the early part of the eighteenth century in regard to the relative merits of the wines of Champagne and Burgundy. The dispute lasted until the year 1778, when the Faculty of Medicine in Paris decided in favor of Champagne. But connoisseurs in many respects, nevertheless, give the preference to the growths of Burgundy. The dukes of Burgundy in former times received the popular appellation of princes *des bons vins*, in consequence of the excellent wines of the province. The soils on which the best wines are produced are, for the most part, light black or red loam, mixed with the *debris* of calcareous rock. The most celebrated Burgundian wines are produced in the department of Côté d'Or. The Romanée Conti is produced on a spot of only six and a half English acres in extent, but is seldom seen in its genuine state. The Clos-Vougeat is from a vineyard of eighty acres. It was formerly the most highly esteemed wine

of the province, but has depreciated in quality with the increase of quantity. The Chambertine wine takes the third rank. It is produced near Dijon from a vineyard of sixty-five acres. It was a favorite wine both with Louis XIV and Napoleon. "Among the stronger wines," says Henderson, "those of Corton, Vosne, and Nuits may be regarded as little inferior to those of the Clos-St. George: they are seldom fit for drinking till the third or fourth year after the vintage, but bear carriage well, and acquire a high flavor when old. The last mentioned, which was extolled by the champion of the Burgundy wines, in the controversy formerly noticed, as a wine '*qui n'a pas son pareil, et ne peut être assez prisé*,' is reported to have owed its high repute principally to the circumstance of having been prescribed as a restorative to Louis XIV in the illness with which he was seized in the year 1680. The growths of Vosne are particularly esteemed for their delicacy." "At Poligny, in the Canton of Nolay, two leagues and a half to the Southeast of Beaune, is grown the famous Mont Rachet wine, surpassing all other white wines of the Côté d'Or by its high perfume and agreeable nutty flavor."

The wine crop of Burgundy, amounting to 62,594,400 gallons, bears an average price far above that of French wines generally; and little, if any, inferior to the growth of Champagne. About 224,000 acres are devoted to the vine in the province. "The difference in the qualities of the wine," says Redding, "may be judged by the following lists of prices, taking, for example, the Arrondissement of Beaune, in the centre of the Côté d'Or. There 2,300 hectolitres of superior wine are produced at one hundred and twenty-five francs each, and 17,700 at ninety-five; 45,000 of fine wines at sixty; 60,000 good ordinary at thirty; and 113,670 of common at eighteen francs." At these rates the first quality would be worth nearly five francs, or, say, about eighty-six cents per gallon; the second about sixty-eight cents; the third about forty-one cents; the fourth about twenty-one cents; and the fifth about thirteen cents per gallon. The lowest of these prices is above the average value of French wines. "In the department of the Saone and Loire eighty francs the hectolitre is the highest price and fifteen the lowest." The best qualities of red Burgundy fetch nearly one hundred and twenty-five francs the hectolitre, while the lowest bring but fourteen francs. According to Redding, the Romanée Conti is considered the best wine in Burgundy. It is only about five acres in extent, which are rated at the fabulous price of 80,000 francs. The Richeburg wine, next in value to the Romanée Conti, is the growth of an enclosure containing six hectares, or about fourteen acres.

THE RHONE AND SOUTHERN FRANCE.

The celebrated vineyards of the Hermitage are on the left bank of the Rhone, near the town of Tain, twelve miles from Valence, in Dauphine. They are situate on the side of a granite hill. They produce both red and white wines, which take a high rank among the wines of France. There are five varieties of the Hermitage wine. The price of the first quality is often as high as twelve francs, or about $2 35 per gallon. It is said that parts of these vineyards have sold as high as seventy thousand francs per hectare, or about five thousand dollars per acre. White Hermitage is said to be the finest white wine in France. The red Hermitage is made from the Scyras or Shiraz grape, said to have been brought from the city of that name in Persia by a hermit of Bessas, an ancient monastery in the vicinity.

The wines of the Lyonnais are celebrated. The white wines of Condrieu, grown at St. Colombe, are the best. The red wines of Côté Rôtie are the most noted of the kind in the province.

Redding says that the red wines and the Muscadines will keep more than a century, and still gain in quality. A French gentleman, on the authority of Cavaleau, (M. de Passu,) had, between thirty and forty years ago, some in his cellar that was made the year of the treaty between France and Spain, 1659. He said he hoped to leave a portion of it to his children in equally good condition, though the best part of two centuries old.

The wines of Roussillon are highly esteemed for their strength and aroma. They are high colored, and retain these qualities in age. "The age of wine," says Redding, "is reckoned in Bordeaux by feuilles, or leaves—the number of times the vine has flowered since it was made. The vine cultivation of the Gironde, in Medoc particularly, is very superior."

Southern France produces the vine and its fruit in the greatest profusion, but the wines of that region are generally inferior. "As we approach the shores of the Mediterranean," says Henderson, "we find the vine flourishing and displaying its choicest fruit under circumstances in which it can with difficulty be brought to bear in the departments of the North—growing vigorously in the freest exposures or under the shade of trees, spreading its branches wide around, and adorning the landscape with its luxuriant foliage." "Nothing," says Dussieux, "can be more picturesque than the prospect which the lofty vines of Provence present to the view. The traveller who is unaccustomed to this sort of plantation

surveys with delight the various productions of the soil where everything bespeaks the symmetrical order of a garden. In one place a range of olive trees forms a sort of espalier, and the pale green of their leaves presents an agreeable contrast to the more lively hue of the corn that grows at their feet. A little further on the vine forms another espalier, or appears in close plantation. Some marry it with the almond or the elm, and its shoots, intermixing with their branches, compose various wild and tufted heads; others again leave it without any prop, and in a fertile soil it sends forth vigorous shoots, which entwine around one another. The mixture of different crops has a charming appearance to the eye, but how many errors are here described in few words!"

Notwithstanding the natural fruitfulness of Southern France, its wines do not compare with those of Burgundy and Champagne, if we except those of the Hermitage. Nevertheless, there are many growths of this region that are highly esteemed. This is true of the red wines of Roussillon and Languedoc. At Frontignac, Lunel and Beziers, in Languedoc, the best Muscadine wines of the Mediterranean coast are grown. The Frontignac wine is known from all others by the very marked flavor of the grape from which it is obtained.

GASCONY AND GUIENNE.

The Medoc, Graves and Paulus wines are the most celebrated of these provinces. The former is produced on the banks of the Gironde and Garonne, in the vicinity of Bordeaux. The vineyard of Latour produces the strongest wine of Medoc. The lightest of the choice Medoc is produced in the Lafitte vineyard. The district of Graves is said to take its name from the gravelly nature of the soil, and is also on the banks of the Garonne. The Paulus district is situated on the banks of the Garonne, opposite Chartrons. Henderson regards these wines as the most perfect which France produces. They keep well and are improved by a sea voyage. The red growths fetch the highest prices.

The Northeastern provinces of France produce little wine, and this is generally of inferior quality. Some few Departments produce none, but it appears that in every province the vine flourishes to some extent.

The district immediately surrounding Paris produces an immense quantity of wine, but it is generally of an inferior quality.

The island of Corsica, the birth place of the great Napoleon, and a dependency of France, produces about seven to eight million gallons of ordinary wine, of which a small quantity is exported.

An American consul in France, writing to the Department of State in 1856, says that "the disease of the vine during the past few years has been very destructive in France, Spain, Madeira, and other old wine-producing countries. Should the disease unfortunately continue in these countries, which have hitherto supplied the markets of the world with this beverage, the day may not be distant when the United States shall become the exporter, instead of the importer of wine."

Only one other product exceeds the value of wine produced in France. The wheat crop is valued at $180,000,000.

SPAIN.

The materials for a history of wine-making in Spain, though doubtless abundant, appear to be but little regarded in the statistical literature of that country. Henderson and Redding content themselves with stating the character of Spanish wines, and only incidentally introduce historical facts. Allusions occur in the ancient Roman writers to the cultivation of the vine in Spain. Ovid speaks of the strength of Spanish wines, while Martial and Silius Italicus compare them to the Tuscan, and even the growths of Campania. The English have been familiar with Spanish wines for centuries, and their poets and writers of fiction, from the times of Shakespeare and Ben Johnson, abound in allusions to the best growths of that country. The tribute paid by Falstaff to Sack is familiar to every reader of the great poet; and Sherry, which is but a time-honored English corruption of Xeres.

Spain has long enjoyed a high reputation among the wine-producing countries of Europe. Its ranges of mountains and hills, which pervade it in all directions, present every variety of soil and climate suitable to the culture of the vine. Wherever good husbandry prevails the vintages take a high rank, and are distinguished, as Henderson remarks, for strength, durability, high flavor, and aroma. But these natural advantages are frequently thrown away, and the result is that an inferior wine is often produced, owing to mismanagement rather than to any defect in the soil or climate. The red wines are often spoiled in fermentation, and become dull and heavy. Spain produces no wine of this class equal to the best growths of France. It is said, however, that in the preparation of dry white wines and certain species of sweet wines the Spaniards are nearly unrivalled. They prefer such as are rich

and sweet, and hence they prefer the products of Malaga, Alicant, and Fuencaral to those of Xeres, which take a far higher rank among foreigners. When Henderson wrote, forty years ago, although wine was produced in the greatest abundance, so rude was the state of society that bottles and casks were rarely to be met with, and throughout the greater part of Spain skins were used by the peasantry to store their wines. These skins were smeared with pitch, from which the wine contracted a disagreeable taste, called *olor de bota.* It was only in the monasteries and commercial towns that subterraneous wine-cellars were known. Some improvement has taken place since the period here spoken of. But the peasantry in the more ignorant and secluded districts show inveterate attachment to ancient customs, and even to the present day use the skins of animals to store their wines.

"The mountains around Granada," observes Jacob, a traveller in the South of Spain in the year 1809, "are well calculated for vines, but so little attention is paid to the cultivation of them that the wine produced is very bad. At the posada where we reside there is only one kind of inferior sweet wine, which is not drinkable; but we had the best proof that good wine is made here in some which a gentleman sent us from his cellar. It was equal to any Burgundy I have ever tasted, and of the same color, without any flavor of the skin. In fact, he had sent bottles to a vineyard, about three leagues distant, celebrated for its excellent wine, in order to have it free from the taste which all the wines here acquire from being brought from the vineyards in sheepskins with tarred seams. It is rather a curious fact that in a country where cork trees abound the trifling operation of cutting them is so ill done, that to have his wine in good order, this gentleman thought it necessary to send to Malaga for English corks as well as English bottles."

This was the picture of Granada fifty years ago. But the recent account of Redding conveys an idea of great improvement. "It is in the beautiful provinces of Granada and Andalusia," says he, "that the wines most valued by foreigners are made, and the favorite species of grape is the Pedro Ximenes. This species enters into all the wines of the country in the present day. When used alone and kept to be old, it makes a choice and valuable sweet wine. The mountains round Malaga are clothed to the summits with vines, one-half of the plants being of the foregoing species. A great number of presses are continually kept at work during the vintage in that and the bordering districts. No labor is spared on the vineyards. Here the benefits of commerce, in spite of all obstacles, have forced their way, and the wine is made in a far better manner than where this active principle of improvement is not felt. The most celebrated wines of this Province are white. There is a wine here flavored with cherries, called the Guindas, the Spanish for cherries. As well as the preceding class, this is consumed at home."

Similar improvements have taken place in the management of the Xeres vintages. This famous wine district is in Andalusia, near Cadiz. Many of the vineyards have for a long while been in the hands of the French and English, and their superior cultivation has been attributed to this circumstance. But similar improvements in wine-making have taken place all over Spain, and are fairly attributable to the progress of civilization and the melioration of governmental administration.

English writers give the amount of Spanish wine imported into that country for a series of years, and our own official documents show the amount imported into this, but of the whole quantity produced we have only vague and loose statements. Henderson furnishes tables of the wine imported into Great Britain from Portugal, Spain, France, and Germany from the year 1696 to the date of his publication, 1822. During this long period great fluctuations and changes in the commercial policy of the British government have taken place, but for the most part it steadily encouraged the consumption of the wine of Portugal, and discouraged that of other countries, especially France. This policy dates, in fact, from the year 1703, when the Methuen treaty with Portugal was formed, prior to which date more than half the wine consumed in England came from Spain. Thus in the year 1700 the importation of wine amounted to 23,502 tuns, of four hogsheads each, and of this aggregate 13,649 tuns came from Spain. During the same year 7,757 tuns were imported from Portugal, and the remainder from the Rhine and from France. Three years later the Spanish column falls behind that of Portugal, and thus remains to the end of the period, with the exception of one or two years. For more than a century and a half the English people have drunk little else than Portuguese wines, while those of Spain have stood next in favor. But the recent commercial treaty with France will probably at no distant day work a revolution in the habits and tastes of Englishmen by withdrawing the monopoly heretofore enjoyed by Portugal.

The Spanish importations into England have been on the increase for some years, but they had not up to 1849 risen to the figure stated above for the year 1700. At the latest of these dates the importation was 2,448,107.

It is stated that Holland and the North of Europe have in some seasons imported 40,000 hogsheads of Spanish wines, or 2,520,000 gallons. It is said that before Spain lost her

American colonies she sometimes exported to them and to foreign countries 350,000 pipes, or 44,100,000 gallons.

La Mancha produces the celebrated wine called Val de Penos, or Manzanares, which is red and of strong body. It is said that the vineyards which produce this wine belong, for the most part, to Don Carlos, the brother of Ferdinand VII, and to the Marquis of Santa Cruz. These wines sell for about twenty to twenty-five cents per gallon at the town of Val de Penos. All the inhabitants of the district are said to be engaged in cultivating the vine.

The wine districts of Catalonia are highly cultivated; and it is said that even the highest cliffs which are accessible are planted with a great variety of vines. Here, as in portions of La Mancha, the Spanish passion for vine culture causes them to neglect almost everything else. The wines produced in this province are not highly esteemed, owing to the carelessness with which they are made. At Figueras, however, the vine is cultivated with care, and the wine made is used in giving body to lighter wines.

Valencia produces a strong red wine, which is exported to France for mixing with light wines. It is called Beni Carlos, from the place at which it is made. Much brandy was formerly made of the strong wines of this province for shipment to this country. The vine district about Alicant is irrigated on a grand scale by damming up a valley by an embankment two hundred feet high and forty feet thick. This reservoir supplies water to the vineyards during the entire year. Another such reservoir is formed in the same vicinity by a dam sixty feet in height. The necessity of these artificial means of irrigation renders wine-making in this province very expensive.

Aragon is not famous for its wines. The kind called Campo de Carinena is said to be the best. But the wines of the Northern and interior provinces are not celebrated, though many of them are good.

It is the wines of Granada and Andalusia, as already remarked, that are most celebrated. "The mountain wines of Malaga," says Redding, "have long been well known out of Spain. The vines cover the hills from the valley depths; the little habitations of the dressers peep out romantically on the declivities from among them. Wines, dry, sweet, and luscious, are made in the districts around the city. There are also several kinds of dry wine. The Malaga, usually so called, is sometimes mingled with a proportion of wine burned a little in the boiling, imparting a peculiar taste. The reason of this is that they are not so careful at Malaga in making the *arropé* for mingling as they are at San Lucar de Barrameda, and, in consequence, the wine gets a singed flavor. It is a powerful wine, in high repute. This wine is from a white grape, and contains a very large proportion of alcohol. The mountain wines are pressed from the grape somewhat riper than for the preceding kind. The 'lagrimas,' which is made from the droppings of very ripe grapes, commonly called virgin juice, is a very luscious wine from the large white Muscatel grape; of course it undergoes no pressure. There is here the Pedro Ximenes, a wine named from the grape so common in most parts of Spain, of excellent quality. The dry wines are pressed from fruit not so mature in ripeness as the sweet. At Malaga, too, there is a white wine produced, of a coarse character, but strong; very like bad or inferior Sherry." This wine is exported to England and America, and sold as sherry.

The vineyards in the vicinity of Malaga produce seven to ten million gallons of wine annually, four-fifths of which are exported, chiefly to this country. The prices vary from twelve and a half to near seventy cents per gallon. The fruitfulness of this district is said to be wonderful.

"The Sherry wine," says Redding, "which some will contend was the 'Sack' of our forefathers, but which was, no doubt, a general name to designate the wine of Xeres, Teneriffe, and others of a similar character, belonging principally to Spain, is made in Andalusia, near Cadiz, on the west coast, between the rivers Guadalquiver and Guadalete. The district included in the Province of Cadiz is of a triangular form, having on the Northern angle the town of St. Lucar de Barrameda; on the Southern angle the Puerto de Santa Maria; and the Eastern point formed by the town of Xeres de la Frontera, from which the wine takes its name, the English having first changed Xeres into Sherres, and finally into Sherry. This triangle encloses a space measuring about twelve miles on each side. The vineyards which produce wine for the English market cover eighty thousand acres. Upward of four hundred thousand pipes are made of all kinds, including those which are exported and such as are consumed in the district." The vineyards are principally on the hill-sides, and the soil is chalky and gravelly.

The famous wine called Manzanilla is also produced in this district. It is said to be perfect of its kind, and to admit of no admixture of other kinds without deterioration. It improves with age beyond all other kinds.

The wines of Spain are rapidly becoming appreciated in value in the markets of the world, and the exportation to England especially is increasing.

The islands of Majorca and Minorca, dependencies of Spain, produce the vine very freely, but the wine is made in a careless manner, and is not highly valued.

The Canaries produce annually about five million gallons of wine, of which two millions are exported, and the remainder distilled, or consumed at home. Teneriffe produces the great bulk of these wines, as well as the best in quality. The vine is said to have been introduced into these islands in the reign of Charles V, being brought from the Rhine.

Redding mentions fifty-three Spanish wines, the principal of which are described above.

PORTUGAL—MADEIRA.

It was the good fortune of Portugal to supply Great Britain with three-fourths of the wine consumed in that kingdom for more than a hundred years, commencing with the year 1703. In December of that year a treaty (known as the Methuen treaty) was entered into between the two kingdoms, by which her Majesty Queen Anne covenanted to admit the wines of Portugal into Great Britain, "so that at no time, whether there shall be peace or war between the kingdoms of Great Britain and France, anything more shall be demanded for these wines, by the name of customs or duty, or whatsoever other title, directly or indirectly, whether they shall be imported into Great Britain in pipes, or hogsheads, or other casks, than what shall be demanded from the like quantity or measure of French wine, deducting or abating a third part of the custom or duty." This advantage was given to the wine of Portugal on condition that that country should admit the woollen manufactures of England on very favorable terms. This monopoly of the English market was immediately visible in the reduced exports of Spain, Germany and other wine-producing countries, while those of Portugal, already considerable, soon rose from one-third part to two-thirds of the whole British importation. In 1697 Great Britain imported 13,086 tuns of wine, of which Portugal supplied 4,774 tuns. In 1701, of 21,443 tuns of British imports, Portugal furnished 7,403 tuns. From this period to 1741 Portugal furnished considerably more than half the wine consumed in Great Britain, and thenceforward to the end of the century more than two-thirds. The greatest quantity of Portuguese wine ever imported into Great Britain in one year was 28,669 tuns, in 1801, when the total importation was 38,893 tuns. In 1809, when the British importation of wines from all countries amounted to 49,762 tuns, the largest ever made up to 1849, when the tables cease, Portugal contributed 20,758, Spain 10,939, and France 13,105 tuns.

The most famous wine of Portugal takes its name from the city of Oporto, near which it is produced, and is styled Port. It is never imported in a pure state; but at a very early period the practice was introduced of mixing a large proportion of brandy with it, in order to please the tastes of the English people. According to Mr. Brande, who applied chemical tests to various wines, Port contains 22.96 parts of alcohol in 100 of wine. Most French wines, it will be remembered, are not above 13 in 100, and the German are below 10 in 100. The strength of wines in general is greater in the warm latitudes, but the English consumers of the article are not satisfied with the natural infusion of alcohol. It is said that the genuine Port is rarely seen out of Portugal, and that it is an admirable wine when free from foreign ingredients.

During the first half of the last century the adulterations of Port wine had become so gross and universal that the merchants of Oporto, in conjunction with certain large proprietors of vineyards, seized the occasion to secure from government a joint stock charter to themselves under the name of the Oporto Wine Company. This company had very extensive powers granted to it for the regulation of the cultivation of the grape and the manufacture and sale of wine, which it made no scruple to use for the benefit of the parties immediately interested. It was instituted for the purpose of reforming abuses, but itself soon became a great abuse, and tended to retard the production and sale of wine.

It is said that twenty-four gallons of brandy are mixed with a pipe, or one hundred and twenty-six gallons of Port wine, besides elder-berries to give it color. This compound is sent to England and to the United States, where it receives a further adulteration.

The district of the Douro, which is under the supervision of the Oporto company, produces about six thousand pipes of wine of the first quality annually. About as much more is made up by mixing or compounding, and about eighteen thousand of the second quality. The third quality is not legally exportable.

Portugal produces the vine in nearly every part of it, but it is only in the district of the Douro that the celebrated wines of the country are made. The vines are trimmed low. This district is upon the banks of the river of that name, above the city of Oporto. It is called the Cima, or higher Douro. The largest vintage of this district was in 1804, when the product amounted to 77,000 pipes.

The province of Beira produces good wine. The vines are of the high growth. It produced formerly a white Port, which was preferred to the red; but the monopolists are accused of suppressing it on that very account. Portuguese wines were known in England as long ago as the year 1600; and Shakespeare alludes to the species called *charnice* in his Henry VI.

It is stated in the volume of "Commercial Relations," already quoted, that the wine product of Portugal in 1851 was 787,809 pipes, or 99,263,934 gallons. The export of wine, brandy, &c., in 1853, was 55,813 pipes, or 7,032,438 gallons.

The island of Madeira is a colony of Portugal, and far excels the mother country in the quality, if not the quantity, of its wines. It was discovered in 1419 by the Portuguese, and colonized two years later. It is probable that the vine was introduced cotemporaneously with the first settlements. Wines were exported from the island prior to 1460. Its hills are high and picturesque, and covered with vines. There are several varieties of grapes. The Malvasia, or Malmsey, believed to have been the first introduced, is said to have been brought from Candia, but more probably from Portugal. Single clusters of grapes in this island have been known to weigh twenty pounds. The Jesuits formerly owned nearly all the Malvasia vines, which were embraced in one extensive vineyard. It is said that Madeira wine was extensively exported to North America and the West Indies more than a century and a half ago. Many varieties of grapes grow in Madeira.

The island produces from twenty to thirty thousand pipes of wine annually, of which a very small portion is considered first quality. Madeira wine has to be retained for many years to arrive at perfection, or it must be sent on a long sea voyage to warm latitudes. In twenty years it attains to perfection, but none has ever been known to deteriorate by age.

The Azores produce, according to Redding, about five thousand pipes of wine, which is inferior to the wines of Madeira. It has been known to Europe for more than two centuries.

GERMANY AND HUNGARY.

It is probable that the vine was introduced into Germany by its Roman conquerors. Tacitus declares that in his age the vine was unknown in that country; but in the fourth century of the Christian era Ausonius, a poet of Bordeaux in France, describes the banks of the Moselle as richly mantled with vines, and states that its produce reminded him of the wines of his native country by its delicate perfume. It is believed that the vine was not cultivated upon the Rhine until the reign of Charlemagne, in the eighth century. Such has been the melioration of the climate in Germany, in consequence of agricultural improvements, that the vine is now cultivated as high as the fifty-second degree of latitude. But the grape in high latitudes lacks the saccharine juice essential to make rich or strong wines. The best German wines, however, are produced above the latitude assigned to the vine in France.

The vine prefers high ground, and consequently the famous wines of the Rhine are made near Mentz. The hills along the banks of this noble stream are covered with vineyards, which give employment and support to a large population. The Rhine wines are among the most celebrated and valuable in the world. The district in which these rare products are grown, called the Rhinegau, is very small, being only about fifteen miles in length by four in width, on the right bank of the river, from Wallauf, a little below Mentz, to Rüdesheim. Hochheim, on the Main, is considered one of the best Rhine wines.

The Johannisberger, according to Henderson, is considered the best of the Rhinegau wines. It is grown on the south side of a hill of that name, a little below Mentz, in the district above described. It has a fine flavor and aroma, with almost entire freedom from acidity. The vineyard is said to have been planted by the monks of the Abbey of Johannisberg near the close of the eleventh century. The bishop of Fulda formerly owned the best exposures and kept the wine for his own cellars. The Prince of Orange afterward came into possession of these vineyards upon the secularization of the ecclesiastical estates; and still later they were transferred to Prince Metternich. "Next to Johannisberger," says Henderson, "may be ranked the produce of the Steinberg vineyard, which belonged to the suppressed monastery of Eberbach, and is now the property of the Grand Duke of Nassau." Only about three hundred hogsheads of this wine is produced. It has a sweet and delicate flavor. The Rüdesheimer, which grows on a hill opposite Bingen, is nearly or quite equal to the Steinberg wine. The vineyards of Grafenberg, Markbrunn, and Geisenheim, are distinguished for their excellence. The above-described wines are all white. The red wines of this famous district are not distinguished.

In recent years the Hochheimer is said to take rank of the Johannisberger, and the latter has found a rival in the growths of Steinberg. All these wines have sold at fabulous prices on account of their age or scarcity. It is said that the best vintages were those of 1748, 1766, 1779, 1783, 1800, 1802, 1811, 1822 and 1834. The Steinwein of 1748 brought seventy pounds per ohm, of thirty-six imperial gallons, in 1832.

Wines are produced in various parts of Germany, but the above are the principal.

According to Homan's Cyclopedia of Commerce, 692,737 acres of land in Germany are devoted to the cultivation of the vine, of which 415,732 are in Austria. The next largest wine-growing country in Germany is Bavaria, which has 79,487 acres in cultivation. The

districts on the Rhine, the Neckar, and the lower Maine produce the best wines. The quantity made is said to be about 3,000,000 of eimers. This statement, however, must refer to some particular district, as it would amount to only about 45,000,000 gallons, which is only a twentieth of the production of France. The English and American authorities furnish no reliable statistics of German wines.

Switzerland produces wine for home consumption only. The best wine of the country is made in the Grissons, and is called Chiavenna. The canton of Vaud produces the largest quantity.

It has already been remarked that the wines of high latitudes have less alcohol than those further South. The same difference is observable between the products of different altitudes in the same latitude.

The Hungarians claim to have had a knowledge of the vine and of wine-making as long ago as the third century. Nothing certain, however, is known on the subject. The annual product of the country is estimated at 180,000,000 gallons. The most celebrated wine is the Tokay, called the king of wines, which takes its name from a town of that name. The other principal wines are those of Ofen, Pesth, Syrmia, Groswardien, Eslon, and Warwitz. The Tokay has been celebrated for two centuries. The Hungarians have an annual fair of wines at Pesth, and the government gives great encouragement to their production. Nevertheless the culture is conducted in a slovenly manner. It is said that there are sixty varieties of the grape in this country.

The Tokay wine resembles the ancient wines in thickness and consistency. The proverb reads: "Spain for strength, France for delicacy, Italy for sweetness, and Hungary for thickness." The best of this wine sells in Vienna for about five dollars the bottle.

Austria Proper produces some good wines, although none of them are celebrated. A German writer estimates the entire wine product of the Austrian empire at 330,000,000 gallons. Others suppose that the product is nearly twice this amount, and say that 60,000,000 gallons are exported. The Archduchy of Austria is said to produce 36,000,000; Moravia, 6,500,000; and Bohemia 400,000 gallons. Wine is also made in the other provinces of the Austrian empire, some of which is very good.

The importation of wine to England from Germany has hitherto been small. Recent legislation may bring about a greater consumption of wines in that country.

The following lists embrace the principal wines, ancient and modern, of which any accounts are accessible to us, together with the country and province in which they are produced:

ANCIENT WINES.

NAMES.	LOCALITIES, ETC.
Abates	Cilicia, Asia Minor.
Aeigleukes	Greek.
Albanum	Roman.
Anthosmias	Greek.
Antylla	Egyptian.
Argitis	Greek.
Ariusian	"
Arsynium	Galicia, Asia Minor.
Autokraton	Greek.
Bithynian	Asia Minor.
Byblos	Phœnician.
Calenum	Roman.
Carenum	"
Caulinum	"
Cecuban	"
Chalybon, (Kalibonian)	Damascus.
Chian	Greek Island.
Circumcisitum	Roman, inferior.
Clazomenian	Greek Island.
Cnidos	" "
Corinthian	Greek.
Corcyra	Greek Island.
Coum	Greek.
Crete	Greek Island.

ANCIENT WINES—Continued.

NAMES.	LOCALITIES, ETC.
Cyprus	Greek Island.
Defrutum	Greek, inferior.
Deuterios	Asia Minor, inferior.
Epsema	Greek.
Falernum	Roman.
Ismarus	Greek.
Labici	Roman.
Lesbos	Greek Island.
Leucadia	" "
Lora	Asia Minor, inferior.
Mamertinum	Sicilian.
Marcoticum	Egyptian.
Maronean	Greek.
Marseilles, (Massilia)	Gallic.
Mendean	Thrace.
Meroë	Egyptian.
Narbonne	Gallic.
Naxos	Ionian Island.
Nomentanum	Roman.
Oligophoroi	Greek.
Omphacites	Greek Islands.
Operarium	Asia Minor, inferior.
Passum	Roman, refuse.
Phanean	Greek Island.
Pollæum	Syracuse.
Polyphoroi	Greek.
Pramnian	Attica.
Prodromos, Protropos, or Prochyma	Lesbian.
Rhodian	Rhodes.
Rhæticum	Roman.
Sabinum	"
Sapa	" refuse.
Saprian	Greek, Chian.
Sciathos	Greek.
Scybellites	Galicia, Asia Minor.
Sebenniticum	Egyptian.
Setinum	Roman.
Signinum	"
Siraion	Greek, inferior.
Spoletum	Roman.
Statanum	"
Surrentine	"
Taeniotic	Egyptian.
Tarragona	Spanish.
Tauromenian	Sicilian.
Thalassites	Greek.
Thamna	" inferior.
Thasian	"
Tibenum	Asia Minor.
Titucazenum	"
Tmolites	Lybia, Asia Minor.
Venafranum	Roman.
Vienne	Gallic.
Zakynthos	Greek Island.

MODERN WINES.

NAMES.	LOCALITIES, ETC.
Ætna	Sicily.
Alba flor	Majorca.
Albano	Italy, Papal States.
Aleatico	" Tuscany.
Alenquer	Portugal.
Alicant	Spain, Valencia.
Amontillado	" (Sherry.)
Arbois	France, Champagne.
Arcetri	Italy, Tuscany.
Artimino	" "
Asmanshaüser	Germany.
Avenay	France, Champagne.
Avise	" "
Auxerre	" Burgundy.
Ay	" Champagne.
Baccharach	Germany.
Bagnols	France, Roussillon.
Barcelona	Spain.
Barsac	France, Bordelais.
Barra-a-Barra	Portugal.
Bassan	France, Languedoc.
Bastard	(Mixed Wine.)
Baune	France, Dauphiny.
Beaucaire	" Languedoc.
Beaumes	" Bordelais.
Beaune	" Burgundy.
Benesalem	Majorca.
Benicarlo	Spain, Valencia.
Bergerac	France, Guienne.
Bessas	" Rhone.
Béziers	" Languedoc.
Bishop	(Mixed Wine.)
Blaye	France, Guienne.
Bodenheim	Germany.
Bouguereau	France, Burgundy.
Bourg	" Bordelais.
Bouzy	" Champagne.
Branne-mouton	" Bordelais.
Braunenberg	Hungary.
Bucellas	Portugal.
Buzet	France, Guienne.
Calabria	Italy.
Canary	Canary.
Candia	Candia, Mediterranean.
Canon	France, Guienne.
Cante-perdrix	" Languedoc.
Caprike	Capri, or Cyprus.
Carbonnieux	France, Bordelais.
Carcavellos	Portugal.
Cariñena	Spain, Catalonia.
Carmignano	Italy, Tuscany.
Cate (vin cuit)	
Cazouls	France, Languedoc.
Cephalonia	Modern Greek Island.
Cerons	France, Bordelais.
Chablis	" Champagne.
Chainette (Clos de la)	" Burgundy.
Chambertin	" "
Chambolle	" "

MODERN WINES—Continued.

NAMES.	LOCALITIES, ETC.
Chaméry	France, Champagne.
Champagne, white	" "
" rosé	" "
" red	" "
Charmes (les)	" Burgundy.
Charneco	Portugal.
Château-Chalons	France, Franche Compte.
" Grillet	" Dauphiny.
" Margaux	" Guienne.
Châteauneuf	" Dauphiny.
Chenas	" Burgundy.
Chianti	Italy.
Chigny	France, Champagne.
Chuzclan	" Languedoc.
Ciudad Real	Spain, La Mancha.
Clairac	France, Guienne.
Clarry	(Mixed Wine.)
Claret	France, Guienne.
Closet	" Champagne.
Collares	Portugal.
Collioure	France, Roussillon.
Columbano	Italy, Tuscany.
Combotte (la)	France, Burgundy.
Commendaria	Cyprus.
Condrieux	France, Dauphiny.
Constantia	Cape of Good Hope.
Corfu	Ionian Islands.
Cornas	France, Languedoc.
Corton	" Burgundy.
Cosperon	" Roussillon.
Côte Rôtie	" Dauphiny.
Côteau Brûlé	" Languedoc.
Cotnar	Turkey, Moldavia.
Couslet (Clos)	France, Guienne.
Cramant	" Champagne.
Crozes	" Dauphiny.
Cumières	" Champagne.
Cyprus	Cyprus.
Die, Clarette	France, Dauphiny.
Dizy	" Champagne.
Dulamon	" Bordelais.
Ecueil	" Champagne.
Epernay	" "
Erlau	Hungary.
Florence	Italy, Tuscany.
Franconia	Germany.
Frontignac	France, Languedoc.
Fuencaral	Spain, New Castile.
Fuissey	France, Burgundy.
Gadagne	" Dauphiny.
Garnacha	Spain, Arragon.
Garnarde	Greece.
Genevrière (la)	France, Burgundy.
Gervant	" Dauphiny.
Gorce (clos)	" Bordelais.
Goutte d'Or	" Burgundy.
Graach	Moselle.
Grafenberg	Germany, Rhine.
Graves	France, Bordelais.

MODERN WINES—Continued.

NAMES.	LOCALITIES, ETC.
Greco	Italy, Naples.
Greffieux	France, Dauphiny.
Grenache	" "
Grenouilles	" Burgundy.
Grisées	" "
Guinda	Spain.
Haut-Brion	France, Bordelais.
Haut-Talence	" "
Hautvilliers	" Champagne.
Hermitage	" Dauphiny.
Hippocras	(Mixed Wine.)
Hochheim	Germany, Rhine.
Isle of France	France, Isle of France.
Ispahan	Persia.
Ithaca	Greek Island.
Johannisberger	Germany, Rhine.
Kisranos	Candia.
Lacrima	Italy, Naples.
Lafitte	France, Bordelais.
Lagrima de Malaga	Spain.
Lamego	Portugal.
Lanarte	France, Dauphiny.
Langon	" Gascony.
Larose	" Bordelais.
La Torre	Spain.
Latour	France, Bordelais.
Laubenheim	Germany, Rhine.
Lavradio	Portugal.
Leisten	Germany, Bavaria.
Lemesnil	France, Champagne.
Léoville	" Bordelais.
Lepe	Spain, Seville.
Lesbos	Greek Island.
Liebfrauenmilch	Germany.
Lojac	France.
Lissa	Greece.
Lisbon	Portugal.
Ludes	France, Champagne.
Lunel	" Languedoc.
Maccabec	France, Roussillon.
Macedonia	Greece.
Mâcon	France, Burgundy.
Mâd	Hungary.
Madeira	Madeira.
Mailly	France, Champagne.
Malaga	Spain.
Malmsey	Mediterranean.
Mantes	France, Seine.
Manzanares	Spain, La Mancha.
Maraussan	France, Languedoc.
Mareuil	" Champagne.
Markbrunn	Germany, Rhine.
Marne (Rivière de)	France, Champagne.
Marsala	Sicily.
Marseillan	France, Languedoc.
Marseille	" "
Mazet (Clos)	" "
Mazzara	Sicily, Messina.
Méal	France, Dauphiny.

MODERN WINES—Continued.

NAMES.	LOCALITIES, ETC.
Medoc	France, Bordelais.
Méneser Ausbruch	Hungary.
Merceurol	France, Dauphiny.
Merignac	" Bordelais.
Mesta	Greece.
Meursault	France, Burgundy.
Migranne	" "
Minorca	Island of Minorca.
Mouçaon	Portugal.
Mont-Basillac	France, Bordelais.
Mont Catini	Italy, Papal States.
Mont de Milieu	France, Burgundy.
Montefiascone	Italy, Papal States.
Montepulciano	" Tuscany.
Mont Rachet	France, Burgundy.
Moravia	Austria, Moravia.
Morea	Greece.
Morey	France, Burgundy.
Morjet (Clos)	" "
Moselle	Germany.
Mount Ida	Greece, Candia.
Mountain	Spain, Malaga.
Musigny	France, Burgundy.
Navarre	Spain.
Naxos	Greek Island.
Neckar	Germany.
Nierstein	" Rhine.
Nuits	France, Burgundy.
Oedenburg	Hungary.
Oeiras	Portugal.
Ofen	Hungary.
Oger	France, Champagne.
Olivotes (des)	" Burgundy.
Orleans	" Orleannois.
Orvieto	Italy, Papal States.
Oseye	France, Alsace.
Paxarete	Spain, Xeres.
Palma	Canary Islands.
Palus	France, Guienne.
Pedro-Ximenes	Spain, Granada and Andalusia.
Peralez	" Valencia.
Peralta	" Navarre.
Perriere (Côté d'Or)	France, Burgundy.
Perriere (La Meursault)	" "
Perriere (Tonnerre)	" "
Picardan	" Languedoc.
Pichon-Longueville	" Bordelais.
Pierry	" Champagne.
Piesport	Germany.
Pitoy	France, Burgundy.
Pomard	" "
Pomerols	" Languedoc.
Pontac	" Bordelais.
Ponte-a-Moriano	Italy, Lucca.
Port	Portugal.
Pouilly	France, Burgundy.
Préaux	" "
Preignac	" Bordelais.
Prémeau (Clos)	" Burgundy.

MODERN WINES—Continued.

NAMES.	LOCALITIES, ETC.
Priory	Spain, Catalonia.
Pupillin	France, Jura.
Rancio	Spain, Navarre.
Ratchdorf	Hungary.
Raucoule	France, Dauphiny.
Raumont	" Champagne.
Rauzan	" Bordelais.
Reims (Montagne de)	" Champagne.
Rethymo	Candia.
Ribadavia	Spain, Galicia.
Richebourg	France, Burgundy.
Rilly	" Champagne.
Rivesaltes	" Roussillon.
Romanée Conti	" Burgundy.
Romanée de St. Vivant	" "
Romanèche	" "
Romaney	Greece, Candia.
Rota	Spain.
Rothenberg	Germany, Rhine.
Roussillon	France, Roussillon.
Rüdesheim	Germany, Rhine.
Sack	Spain.
St. Basle	France, Champagne.
St. Bris	" Bordelais.
St. Croix du Mont	" "
St. Emilion	" "
St. Geniez	" Languedoc.
St. George, (Côté d'Or)	" Burgundy.
St. George d'Orgues, (Herault)	" Languedoc.
St. Georgy	Hungary.
St. Jean, (Clos)	France, Burgundy.
St. John	Italy.
St. Joseph	France, Languedoc.
St. Laurens	" "
St. Nessans	" Bordelais.
St. Peray	" Languedoc.
St. Thierry, (Clos)	" Champagne.
Salces	" Roussillon.
San Lucar de Barrameda	Spain.
Sancé	France, Bordelais.
Santorini	Greece.
Sauterne	France, Bordelais.
Savigny-sous-Beaune	" Burgundy.
Scharlachberg	Germany, Rhine.
Schiller	Hungary.
Schiracker	"
Scio	Greek Island.
Segorbe	Spain.
Sercial	Madeira.
Setubal	Portugal, Estramadura.
Seyssuel	France, Rhone.
Sézanne	" Champagne.
Sherry	Spain.
Shiraz	Persia.
Sillery	France, Champagne.
Sirmien	Hungary.
Sitges	Spain.
Smyrna, Muscadine	Asia Minor.
Sorgues	France, Rhone.

MODERN WINES—Continued.

NAMES.	LOCALITIES, ETC.
Stein	Germany.
Steinberg	"
Suabia	"
Syracuse	Sicily.
Tabriz	Persia.
Tâche	France, Burgundy.
Taisy	" Champagne.
Tállya	Hungary.
Tarczal	"
Tart, (Clos du)	France, Burgundy.
Tavel	" Languedoc.
Teheran	Persia.
Tenedos	Greek Island.
Teneriffe	Canary.
Tenos	Greek Island.
Termo	Portugal.
Terrats	France, Roussillon.
Tintilla, or Tinto	Spain.
Tire	Syria or Sicily.
Tisanne	France, Champagne.
Tokay	Hungary.
Tonnerre	France, Burgundy.
Torémila	" Roussillon.
Torins	" Burgundy.
Torres Vedras	Portugal.
Trebbiano	Italy, Tuscany.
Tyrol	Austria.
Val de Penas	Spain, La Mancha.
Valmur	France, Burgundy.
Vaucluse	" Rhone.
Vaudesir	" Burgundy.
Vaumorillon	" "
Verdea	Italy, Tuscany.
Verdona	Canary.
Verinay	France, Rhone.
Vernaccia, or Vernage	Italy, Tuscany.
Veroilles	France, Burgundy.
Verzenay	" Champagne.
Verzy	" "
Villedemange	" "
Villeneuve-en-Rioms	" Bordelais.
Villers-Allerand	" Champagne.
Vin cuit	(Boiled wine.)
Vins de cargaison	France, Bordelais.
" de cotillon	" Rhone.
" d'élite	" Champagne.
" de paille	" Rhone.
" de primeur	" Burgundy.
" rapés	"
" secs, (Sack)	Spain. (Dry wine.)
" de taille	France, Maine.
Vinaroz	Spain, Valencia.
Vino Santo	Italy, Lake Garda.
Vino Tinto	Spain, Valencia.
Volnay	France, Burgundy.
Vosne	" "
Vougeot, (Clos)	" "
Wehlen	Germany.
Wermuth	Hungary. (Mixed wine.)

MODERN WINES—Continued.

NAMES.	LOCALITIES, ETC.
Xeres	Spain, Andalusia.
Yezd	Persia.
Yquem, (Clos)	France, Bordelais.
Zante	Greek Island.
Zettingen	Germany.

CULTURE OF GRAPES IN GRAPERIES.

BY S. J. PARKER, M. D., ITHACA, NEW YORK.

In what is here said of the culture of foreign varieties of grapes, novelty will not be attempted beyond the freshness of the individuality of one's own mind.

The culture of choice foreign grapes under glass in this country dates from before the war of independence, from which time to this the fair-looking Sweetwater, the perishable Chasselas, the delicious Frontignac, and the luscious Hamburg have been here and there carefully ripened—efforts mainly confined to the vicinity of large cities, isolated, and, to the surrounding inhabitants, a mysterious luxury of the more highly educated and rich. Not until of late has the idea become justly prevalent that no American citizen possessing a homestead, no matter how humble, need be without his own out-door vines, and his grapery, with its glass gleaming beneath our crystal sunshine. Not until recently has the simplicity of grape culture been understood, or have we had the patience to await its sure results.

We have supposed out-door vines required only to be planted and let alone, and if they did not bear of themselves, without pruning, the fault was in our climate—ideas too prevalent yet with the great mass of our inhabitants. We have been led to believe in-door culture to be so complicated an art that none but imported vine-dressers could accomplish the task—an impression most skilfully continued by this class of persons; while we have forgotten that in mechanism, art, and agriculture our real advancement lies mainly in native-born talent, and that when self-reliant we make progress. We have only just begun to learn how little time and care a grapery, giving as much as the family can eat of these heaven-born fruits, requires; how surely tons of them can be raised for the market by the thrift and versatile talent of our own citizens. It is true the glass grapery cannot be neglected, nor can the laws of growth and ripening be disregarded with impunity. Still, it is by a very simple fixed routine, easily understood, that these delicacies are ripened so as to melt in multiform flavor on the palate.

Nothing cultivated needs less care, is more easily managed, or more certain to be a successful crop, throughout the whole domain of the United States, adding to the millions of our products.

He who studies the matter for himself will find no complicated rules nor wonderful secrets to be learned, but everything so plain that a child may learn what is requisite, and the labor so small, when the system is acquired and the few necessary mechanical implements rightly made, that the invalid or the youth can do the work.

A single reflection on the main causes of the coldness of our climate will show the need of glass for the culture of these varieties of grapes. We have a continent more narrow than others at the South, growing more wide, but which does not expand to its vaster width until the regions of perpetual ice are reached towards the pole, where unfortunately it attains its greatest breadth, and sterile, cruelly cold, as it is, clings, perhaps without the "open sea" so fondly dreamed of, to the pole itself. It is to this vast icy region, the utility of which is not very apparent, we must attribute the cold so contrary to our feelings,. Another cause, if the theory of prevailing upper currents is true, is that we are again unfortunate in being on the Eastern, instead of Western shores of the continent; for the corresponding cold region of Asia, with its tuberculous consumption, is there due to the loss of oceanic heat, that makes Oregon and California, as well as Eastern Europe, with a more healthful climate for the lungs, ripen fruits better than the Eastern States. But be this as it may, it is to the unusual formation of the continent, and to the ice of the Northern

portions of it, that, despite a genial sunshine, with remarkable purity of atmosphere, are due the cold and frosts that mar our products, and which by a sweep of a vast "*Norther*," or cold-bearing north wind, at times cuts off a whole cotton crop when slightly above the ground, compelling, as the writer has himself seen, every planter, even to the shores of the Gulf, genial as the climate there is, to replant his cotton as late as April or May, thus doing over again, often when seed is scarce, the whole spring's work.

The same cause, later in the spring, cuts off the peach, apple, and the promising corn of the Northern States, and even in June desolates the Canadas. It is this, with the consequent cold night air and skies, that sends mildew and rot into our foreign grapes.

So that from the Northern Lakes, almost or quite to the far Southern cotton lands, he who would taste the fruits of Egyptian, European, and other Eastern vines, so exquisite, must rear them under the protection of glass. And the main elements of the details of their growth arising out of this same fact can be stated in a word to be, *the further North the more completely must the vine be under control.* The "border," that word so unmeaning to the ordinary American reader, or the soil in which the vine grows and has its roots, at the extreme North must be wholly within the house, to enable the culturist to give or withhold water, heat, and air at pleasure. The Middle States may make the border partially in and partly out of the house, and at the far South it may be wholly outside of the glass, unless the control of moisture be an object. The same rule applies to ventilation. The North must ventilate cautiously at the roots; the South may copy the open foreign ventilation, or have the house wholly open at the roots.

On these facts, more than others, should, the variations of the structure of vineries be made.

The main essentials of Grapery cultivation are: a *suitable border*, that is, a suitable soil and shape or spot for the soil to be in for the growth of the vine; a *suitable house of glass; suitable ventilation*, or means of supplying air; an *ample supply of water*, as near the temperature of the soil as possible; and a *choice stock of vines.* These obtained, there is no one in the family of a farmer or planter, the laboring man, mechanic, or professional man, as well as man of leisure and fortune, who cannot do the rest.

The daily routine resolves itself into the opening the house for ventilation, the closing the house or stopping the ventilation at suitable hours, soon learned; the watering to suit the state of the vines and fruit; checking overgrowth, or promoting growth or renewal of the wood; and guarding against or destroying insects and disease.

This is assumed as the routine, not because more cannot be done, for there are complicated modes of forcing the vine, and fanciful rules, laborious enough; but of these neither time nor utility demands particular mention. The fact that under so many details, so many varied plans, the vine bears nearly alike, most emphatically declares the vine *endures* but does not *need* these arduous trainings, endures rather than is benefitted by them. Thus there are graperies scarcely watered the whole season; others watered night and day, from eight to ten times in the twenty-four hours; one only by broad sunlight, another at sunrise and sunset; one with the vines cut, girdled, and mangled, another left to the greatest freedom; one with a never-varying thermometer, another with the most abrupt changes of temperature. Now it is not said that these diversities produce no perceptible results, for such is not the case, but it is a matter of surprise that the vine bears so uniformly under them all; this one fact showing another more important, that the pains taken beyond a certain limit is only, in the blunt old proverb, "the labor for the pains." Therefore it may be boldly asserted that any one of competent, ordinary skill can in a single season learn to set, at a given hour in the morning, say at nine o'clock, his ventilator for the probable temperature of the day, and at another hour, say an hour before sunset, close the ventilator, and he will be surprised to find how very few days of the season he will have failed in setting the gauge mark as he ought; how rarely a sudden change unanticipated has come. Or if he prefer the usual meal hours of the farmer, say 6, 12½, and 6½ for the summer, he will find a few moments thus at morning, noon, and night, will be all the time he need spend to do the whole work of the grapery; especially if a wife or child is at hand at the hour of 10 or 11 a. m., to cast an eye on the thermometer, and slightly modify the temperature, if necessary. Thus, in these few leisure moments of the day, he can accomplish everything, except when the fruit is setting or "the bunches are to be thinned," and even these he can see to, if he cultivates only for his own use, by a little more attention for a few days at these times.

Still further, to see how simple is the routine, read the published thermometrical records of various persons, and the results on the fruit. One reads 90° to 110°, another 80° to 90°, another 60° to 80°, and some speak, incredible as it may seem, of even 150° to 200° or more at times in a damp atmosphere. Yet they inform us they ripen their fruit in about the same time.

Sometimes the lowest degree ripens the fruit best. Again, one says, "open at night for some ventilation," another says, "do not ventilate at all at night at any time," and each ripens good fruit. So that among these diversities the whole attendance daily resolves itself into *do not burn the fruit by excess of heat, and adhere rigidly to any plan of temperature that may be*

adopted. Or, in other language, commence your grapery and take care of it by the simplest, shortest, and most efficient plan you can devise, and the luxuriant bunches are yours.

The national importance of fine fruit needs no remark here; the only object is to make plainer the simplicity and certainty of grapes under glass. The peach of the South, so plentiful in some parts as to cause the peach brandy-still to be more common than the cider-mill of New England, evinces how readily it can be grown. The farmer of the Middle and Northern States, with his hundred varieties of apples, peaches, pears, and plumbs, often in a year fruiting fully that number of varieties to perfection, adds to the national wealth. And could every one of these be persuaded to put up the glass structure more would be gained in production. Now, when several thousands of graperies are being built, it is no more than a duty that the Agricultural Division of the Patent Office should exert its influence, so happy in other respects, on the practical cultivation of these time-honored fruits. With the rush of American enterprise we are, in the Yankee phrase, "going into" grapes. We need progressive conservatism. The old well-tried Isabella yet wins, as a table fruit, the race over most of our out-door varieties. The Catawba, for wine, and the Hamburg under glass still takes the palm. Soon he who goes from Maine to the Rocky Mountains will see vineries everywhere over much of this territory. They are now being built, and they should be made wisely. How far they may be extended South experience must tell. At the North there is no choice, they must be built there, and it is believed everywhere over our national domain. Wealth is already expending on them her hardly-valued thousands, and poverty, too, counts her dimes as she builds them. That they may be tastefully made to ornament the grounds of any mansion can be attested by copying from the Gardner's Monthly the design of one of the most common in an Eastern State. As the owner states that he considers the drawing to be inferior to the house, his name is not given, merely saying, in reply, that the beauty of his design cannot be hid in any drawing. (See Plate 2.)

This design gives us very neat lines of beauty in the shape and arrangement of its glass work, an effect from a fine architectural mind, and the whole commends itself to every lover of good building. If criticism on it might be indulged, it would be to say that the cornices at the ends are represented as made of wood, and as being as wide as one of the frames of sliding sash in the roof. Now the sash frames are at least two feet wide, so that the shadows of the cornices falling at all times on a portion of the vines, cutting off so much sunlight, must act to the prejudice of the practical utility of the house. The same remark applies to the projection of the eaves of the house; they also cut off too much sunlight. These, it is believed, are faults, even though the owner says his vines are in an admirable state of health, and bearing fully. It is pleasing to see the comparative distance from the ground to the roof so small, while the roof is comparatively so large and steep. This is as it should be. Theoretically, the eaves of the house should never be over two feet from the surface of the border inside of the grapery. All distance over that is lost space, for the perpendicular sides of the house never fruit well, and the elevation of the roof above the border or soil inside of the house is a violation of the inflexible rule that *sunlight through glass acts in the best manner only a very small distance from the glass*, a foot or two at the furthest, rendering healthy vegetation a distance from the glass impossible. Still, in the design just given, the only greatest loss is in time for the vines to get vigor to bear above the eaves, a fact too well proved by experience to admit of a doubt. However, the few clusters of the few first seasons may flatter the beginner into the hope that high perpendicular walls are advantageous. If while requesting architects to keep the cornice of the grapery low, and make the roof steep and large, they say they must have room for the display of their art of the beautiful, the reply is very true, but not at the expense of the vines and fruit. One thing is certain, either the mass of grape-growers do not know how to fruit year after year on the perpendicular sides of the house, or the vines will not set their fruit and ripen it well there, and if the latter is the fact, the architect must bow to Nature, and not Nature to the architect.

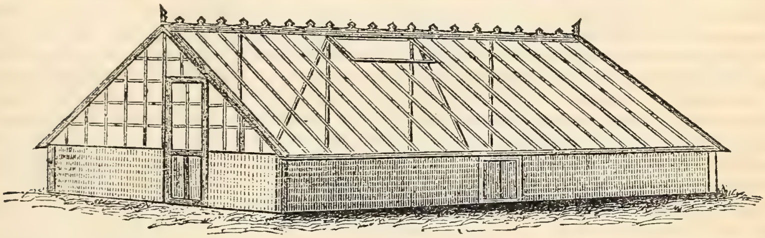
It would be well could two secrets of grape-culture be whispered in the ears of professional architects of graperies, so that they might never forget them. One is, *the whole house should be of glass*, if possible, without a single dark shade, no matter how small. The other is, *since support for the glass must be made* of opaque substances, that cast a shade more or less to the injury of the vines, *make them as small as possible*, and in the varied line of beauty in which these lines of support are worked, and by them let the architectural ornament be given; except on the North side of the grapery, on which side or end alone put heavy wood ornaments, loading this with entablature, heavy, high-wrought cornice, carved wood, marble, alabaster, or other figures, but be so kind as to let the sunlight alone on the East, South, and Western sides or ends. And if you cannot satisfy your taste for agricultural ornament otherwise, select the site of the grapery, so that from the cottage or mansion, the road or avenue, the town or landscape to be adorned by your skill in the vinery, this North end alone shall show, cutting off the prospect of the rest of the house by trees or other objects, so arranged that while they are not too near the vinery they may accomplish the purpose. Bear in mind also that you cannot represent glass on paper, but that glass in the sunshine amid foliage needs little besides its own lustre. There may seem to be one more step than is needful in what has

just been said, but the sins into which the wealthy have been led unawares, as well as the ruined vines, tortured trees and plants that have suffered in silence these many years in many a vinery and green-house, call for an administration of justice by some kind of remark.

Another reason for calling attention to the grapery just given in the figure is because it is represented as standing on a mound, thus giving two results of value, the elevation of the house into better sunlight, with a happy artistic effect, and for the reason of a border, which is thus perfectly drained.

But as this article is written rather for the humbler citizen, contrast with the above another, a "cheap" structure, copied from the "Horticulturist," as it is continued by the successors of the lamented Downing. Mr. A. C. Hubbard, of Detroit, Michigan, says: "I planned it and built it myself, as I had leisure and fancy in the winter season. The materials did not exceed $65. It need not cost over $120." A very reasonable outlay for a house that must be about 12 feet by 20, if his plan is understood, and should be 20 or 22 feet wide and not less than 40 feet long, where the site admits of these dimensions.

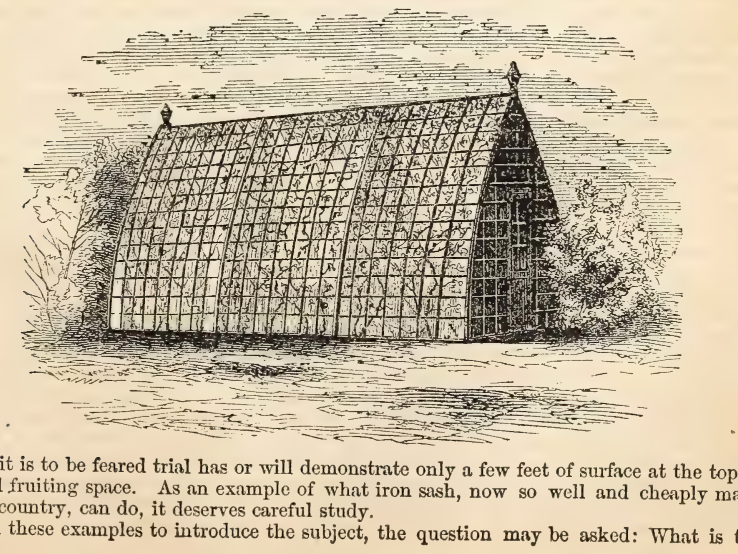
Fig. 2.



This, if made as it should be, will give for one dollar as much as ten, or even fifty dollars, in the costly built grapery of wealth. That is, foot for foot of glass, will give as large, as high-flavored, and as many clusters of grapes as in one of elaborate architectural finish, and may have elements of success and facility in taking care of it not found in many others. Doubtless it looks as a series of black lines on paper, for that is all there is of it; but when amid trees enlivening a landscape view, it is a thing of beauty and life.

But here is another—a gem on paper—a sample of the ethorial lightness of iron sash. It shows that a grapery may be beautifully graceful without a load of so-called architectural ornaments. As a plan to be copied, it may be faulty in being too high for the width. The top ventilation is either not represented or is entirely omitted, and it is not clear how that at the bottom is effected.

Fig. 3.



And it is to be feared trial has or will demonstrate only a few feet of surface at the top to be good fruiting space. As an example of what iron sash, now so well and cheaply made in this country, can do, it deserves careful study.

With these examples to introduce the subject, the question may be asked: What is the

best grapery? Or, to begin at the foundation, How can one best build a grapery? The reply is not difficult.

Select a spot which, while pleasing to the taste, has the best sunshine, with as good a defence from the prevailing cold winds as can be commanded. At the extreme South this rule may possibly need to be reversed and the action of winds sought, for the good of the vines. Let there be an open space about the site, free from trees, dampness, or cold currents of air descending a ravine, or any other source of cold or mildew. Let there be no tree within one hundred feet of the house. If trees cannot be avoided, let them be on the North side of the site, and let there be at least ten feet from the ends of the branches to the house. On all other sides let not even a favorite shrub remain, as experience has shown mildew may come from it when least expected. Select the driest sandy loam, a sheltered hillock or top of a roll or swell of land, a few feet higher than the ordinary level; reference being had also to the conveniences of an abundant supply of water, which, if possible, should be from a running *never-failing* spring, requiring no pumping or artificial manual elevation. Do not, on any account, take the old plan of digging in the hill side and putting the vines in a sort of cellar, unless it is designed to force the vines by artificial heat through the winter months, nor then if the forcing does not commence before the first of February. From November till March the cellar excavation and cold stone wall, that can never be heated, may absorb less heat than the zero air and Northwesters through the glass. Having selected the most suitable spot, commence by digging down a certain space, say two feet, and filling in loose stone to secure perfect drainage for the border or soil, and, if necessary, make a drain from the bottom of the excavation to any point that will keep the stone drainage free from water. If the excavated earth is not fit to use as soil for the inside of the grapery, pile it outside of the excavation as a raised mound; but if it is good enough for the border or soil inside of the house, then, mixing it with lime, manure, and compost, pile it on top of the loose stone with which your excavation is filled, making the inside soil as you want it to be. This will be more perfectly understood by the outline sketch, figure 4.

Fig. 4.

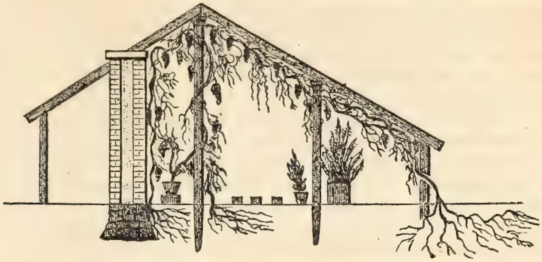
In this the dotted line excavation is seen to extend both within and without the house, as far as the mound to be raised reaches, taking for granted that the soil needs only the special fertilizers to make the border; so that the stone, coarse gravel, or sand, broken brick, or other drainage material, are filled in to the level of the natural surface of the ground, or a little above it, and the replaced earth is put over the stone or other filling mingled with the fertilizers, the work being done by sections for the sake of economy. But if the soil of the site be not suitable for the border, then pile the earth outside of the house for the mound, and do not dig so deep nor so large an excavation, as earth will be needed only for the outside mound, filling in drainage material as before, and bringing decayed turf or other good soil from elsewhere to fill the inside of the house, composted with rich manures. By this plan, it will be seen, there is the dry mound above the general surface level, thus insuring dryness and sweetness to the soil, elevation into a better sunlight with conspicuity of the house, and also a well-worked, rich border, entirely under command.

This plan further gives the choice of making the outside mound a part of the border or not, as desired, though it more than hints that such outside border had better not be made. Notice at this moment that the outside mound must be so wide as perfectly to exclude frost from entering the house from the edges or grass sloping banks; that is, it should be over three or five feet wide, and as much more as your taste demands, but not wide enough to defeat drainage or dryness, as a very wide outside grass plot might do.

On the question of outside borders there are many opinions. Probably the history of graperies will show that the germ of the idea grew out of the fact that vines ripen further North when trained against stone or brick walls. The wall was next protected by glass, close to the vine and wall; then the glass was removed further from the wall. At last the grapery took the shape of a lean-to structure against the wall, a form it yet inflexibly retains in the minds of many. And all this while the border was considered to be next to, but separated from, the wall, and extended some distance from it; and as the glass and vines were removed further from the wall in widening the house, so the border was removed further and further, being all the while kept outside of the glass work. Hence the idea that an outside border is absolutely necessary in the estimation of some. But to American taste walls are not pleasing and the climate destroys them, and thus the idea is of standard trees, standard bushes, open trellis, roomy out-door exposure; and hence, when we find a span-roof house and an inside border, it suits our natural taste, as more like Nature, and as

nearly as can be like a Southern climate artificially created under an extreme untrammelled roof of glass. Now, to add to this, an outside soil or border, for the roots of the vine to run in, is, to say the least, an unnatural thing. The effect of tradition will need long to be combatted, especially as it comes over the ocean, venerable with age and recommended by wealth. To see the more readily the truth of these remarks, please examine figure 5.

Fig. 5.



This is a lean-to English style the vines are planted outside of the house, and led through holes in the walls, and trained up under the glass. This strange anomaly of the roots of Southern, and of some varieties, almost tropical vines, exposed to the cold air and rains of the North, has the further singular recommendation of a border, from twenty to sixty feet wider than the house, and wholly outside of the house; which certainly is as far removed as possible from the dry, warm soil and air of their native climes. Though the certainty that the roots will run to the extent of such outside border cannot be doubted, yet the propriety and necessity of their doing it may be so. It is only a more convincing proof how forbearing and disposed to do well the vine is. But the present object is not so much to remark on this subject as to point out the temptation offered by precedent to copy foreign borders in the colder soil of America. Remember that North of Richmond, Virginia, but a little over two months of the year is the soil warm enough for the growth of most varieties of these grapes; and then to no great depth below the surface, and hence the reasonableness of the important fact that the rest of the year the grapery, be it "cold," that is, not heated artificially, or be it "hot," that is, heated by stove or flues, steam or hot water pipes—in both cases—the grapery or the vine roots, as well as branches, fruit and leaves, need to be completely removed from the cold air of the climate, and the cold spring, fall, and winter rains; so that insiped sap shall not be obtained from the soil to the injury of the fruit. Therefore it is that every native born citizen is daily growing more decided in his convictions, that outside borders are injurious to the fruit, as well as a useless expense. So it is summing up the best practical good sense of the land to say: In the extreme Northern States, North of Richmond, Virginia, build the walls of the grapery down to the stone drainage, so as completely to cut off the passage of the roots outside of the house; and enrich to a higher degree the soil inside of the house, and simplify the culture by supplying them all the elements of growth. South of Philadelphia, and certainly of Richmond, extend to some degree the border outside of the house, as recommended by English authors, and the more so as you go further South, until at or near the Gulf the vine stumps and roots may be placed, perhaps, entirely outside. But it deserves to be repeated that at the North, as experience has shown, or will show, the vine succeeds better when wholly within the house, and thus perfectly under command; an impossibility with a cold uncontrollable outside border. It is to be feared, if this plan is not adopted, a cold rain in June or July will fill the vinery with mildew, or a late rain or cold fortnight, while ripening the fruit, will render the grapes insipid and colorless, even though they have escaped the early mildew.

As a variety of the plan of making the border, drainage and foundation of your grapery, another phase is given, which in some places will lessen the expense, as no excavation is to be made. It consists of the essentials of the last figure, (figure 5,) with the exception of the excavation. The material used is brought to the site of the grapery and piled on the natural undisturbed surface of the ground. This will enable one to build anywhere, irrespective of the soil or other relative disadvantages of like nature, and where the cartage of material is a small object. On this plan, the dimensions of the vinery being marked out, the walls of the house, whether of wood, stone, or brick, can be built directly from the natural surface to the glass work, and the drainage material piled on the surface, sufficiently deep to secure dryness, or to the distance allowed for it in building the walls; the outside mound or grass plot being built of inferior soil, while two feet deep on the inside of the house is filled in with the rich mingled soil of the border; thus arranging the whole foun-

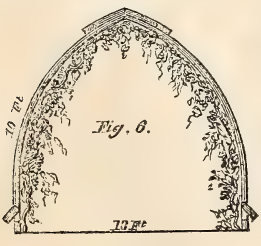
dation work and border just as one pleases, and with an accuracy not always obtainable by any other mode. As a guide to the relative sizes, suppose a span-roof house is to be built. Let the size of the house be 20 × 50, or 22 × 100 feet; for this drive stakes, then outside of these drive other stakes, as the mound is desired to be 6, 10, or 15 feet, wider than the first stakes. Allow fifteen inches for drainage material, composed of coarse sand gravel, stone, or broken brick, cinders of furnaces, or any other most convenient and suitable article; build the walls and complete the rest as suggested by the data already given.

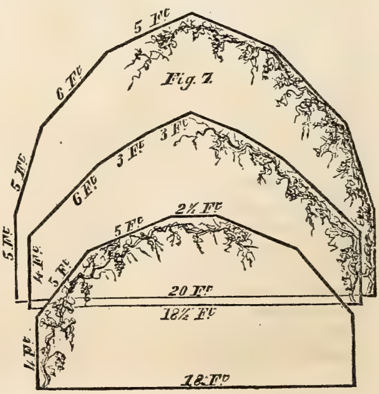
At this point please notice that a border two feet deep is recommended as sufficient; for the European border of six feet deep may be considered not only an unnecessary expense, but as a positive injury to the vines by the acidity and deep coldness produced thereby. Observers, too, of much experience tell us that the slow decomposition in such excessively deep borders generates acidity. It cannot be disputed that no sun-heat penetrates to these great depths so as to exert much influence, and everywhere in Europe and America the tree or vine with its roots in a light porous shallow soil ripens the best flavored fruit. As to the expense, few are aware how great is the labor of digging out even two feet deep, mixing in the fertilizers, and replacing the soil. When four other feet are added to this task, at a greater proportional expense, the advocate of this practice must thoroughly prove its necessity and disprove the now well-founded belief that vine-roots as well as dwarf pear-rootss need and are better to be as close to the surface as possible.

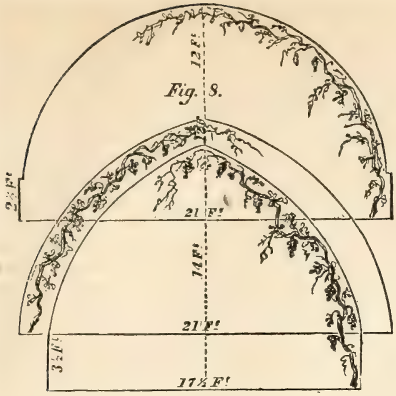
Next comes a question which, in fact, must be decided before the excavation raising the mound, or otherwise preparing the ground or laying the foundation, is done. What is the best plan of building the house or grapery edifice? In reply it may be said old well-approved authors recommend what are called lean-to structures—a style sufficiently seen in fig. 5, already given for another purpose. Reference to that figure shows, irrespective of the site and border, this vinery as consisting of a front towards the South; a large glass roof, at a low angle, also towards the South, and the main source whence the sunshine is received; a small reflex or Northern glass roofing, used often for ventilation, and a North wall or back of the house, built of brick, stone, or wood, made hollow and filled with tan-bark or other non-conducting material. In some instances elaborate designs are given for convoluted, zigzag, or otherwise arranged smoke flues in this back wall for heating the grapery, which are costly arts. And still further, to render this wall on the North side of it available, sheds are recommended to be built, adding further to the expense.

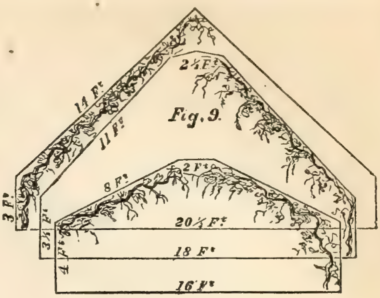
There are, of course, places where, in preference to every other, this is the true plan for a vinery; but it is believed to be the most expensive plan that can be adopted for the number of vines it will fruit well. Rather adopt the span-roofed or double-roofed house, with one roof to the East, containing as many main vines as the "lean-to house" will fruit; for the fruit on the back wall, from the secondary or adjunct vines, is, at the best, but poorly ripened; and another roof to the West, which contains as many more main or principal vines; thus doubling the fully exposed vines; and on the columns in the centre or interior portions of the grapery put the adjunct vines, of which there can be one, two, or three rows, if desired, which will average as well as the one row on the old English and French brick or stone wall. Thus, at an expense of but little, if any, over the "lean-to plan," there will be two rows of main vines, and there may be three rows of secondary or "wall vines," and all fruited as well or better than on the old and now nearly abandoned style of house.

Of these double-roofed houses the three first figures of this article are views in perspective, and they possess greater beauty of design than the old traditionary plan, and are capable of a vast variety of detail. Figures 6, 7, 8, and 9 are sections of houses on this plan:





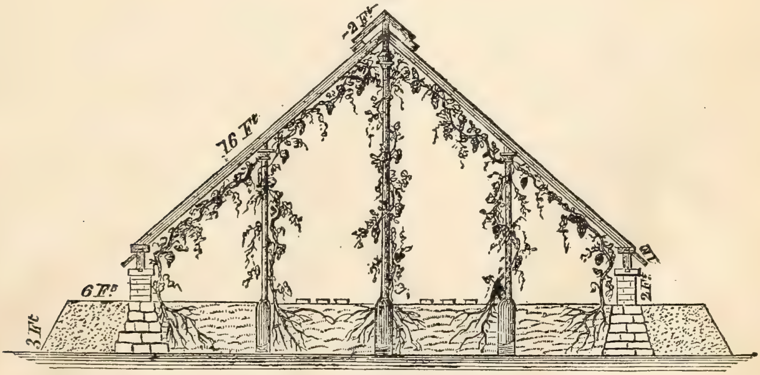




It needs but a glance at them to see they have but one principle—the making them so freely of glass that the vines are as nearly like being out of doors as can be, exposing them to light on every side nearly as much as if situated similarly without glass. They each have, it is believed, certain advantages. Thus fig. 6 causes rapid growth of wood, but its steep sides and narrowness renders only the upper and more circular part good bearing surface ; the fruit below not being ripened as soon, and less plentifully. The models 7, 8, and 9 are better shapes in these respects.

For a plain, economical house, fig. 10 is recommended as a very satisfactory way of building a grapery. The roof is a right angle at the ridge. It can be built of wood wholly, or the part below the ventilators of stone or brick and wood above, or the ventilators and roof may be of iron. But it is not necessary to give in detail plans for iron sash, nor recommend it as desirable for the ordinary American homestead, as long as wood is so abundant and will last ten or twenty years, with no more cost of repair than the iron sash, and so long as a grapery of wood, erected for less than half of the costly edifice of wealth, will fruit as many and as choice pounds of grapes. Too much already has been done, more for the benefit of the architect and builder then for the vines. For permanent luxury nothing is too extravagant for the plain homestead. Simple efficiency is the most appropriate.

Fig. 10.



As a reasonable and durable way to build, as in fig. 10, lay the foundation in stone or brick, the best materials, least affected by the weather. On the top of the wall thus built lay a wood-sill, well coated with coal-tar and linseed oil ; or, if it can be done, kyanise the sill. Let the sill be two or three inches thick, and as wide, or a little wider, than the wall, so as to protect the wall from the drip inside and the rain outside of the house. Now mortice in at about three feet apart, on the sides and ends, the studs or uprights for the ventilators, and cap these short studs, only four to twelve inches long, with a plate two or three inches, and four or six inches wide, which plates receive the lower ends of your immovable sash rafters, the ends of the house being closed by the continuation of the plates,

just over the ventilators, by perpendicular movable sash, extending from the end-plate to the rafters. Experience has shown that rafters one and a quarter inch thick, and two and a half inches wide, are stout enough, if the roof is as steep as it should be. As the greatest liability to rotting is at the ventilators and foot of the rafters, thoroughly cover these parts everywhere, in the mortices and unexposed as well as exposed parts, with coal-tar and linseed oil, half and half boiled together; use durable wood, kyanized, if it can be got. The ventilators below the eaves are simple inch boards, battened on the inside or outside to keep them from warping, and hung to the plate by any convenient kind of hinges. The board ventilators are wide enough if not less than four inches or over twelve inches wide, and should be hung along the whole sides and ends of the house, painting the inside and edges with the coal-tar and linseed oil, and the outside with white lead or other color. The ventilators may be pannelled and they will look better, or a row of panes of glass set in sash ventilators, if thought best, but they will be no more useful. It is, on the whole, advisable to put on eave-troughs to carry off the water that falls on the roof, if there be a supply by a spring, or to fill the cistern, if that is the source for irrigation, as well as to save dampness in the wall and in the soil of the mound. Of course, it will be understood that the rafters are grooved for the glass and do not slide or open. As guides for size, twenty-four inches may be given as the distance from the border inside of the house to the glass, do not exceed thirty-four inches, and twelve or fourteen feet from the border to the ridge of the house. Length of rafters, about fourteen or sixteen feet. The top ventilation is a matter of more difficulty, for the following demands are to be met: Enough of it, complete control over it, and that it be water and air tight. It is at the top of the house and cannot be ordinarily reached, except by the apparatus for opening and closing; the heat is apt to warp it, and thus render it not air-tight and to make it leak. To remedy the defects of the top ventilation many plans have been suggested. A good one is seen in fig. 11, from the Horticulturist, and with the assistance of Mr. Davis, a successful grape grower of this place, the modification found in fig. 12 has been given.

Fig. 11.

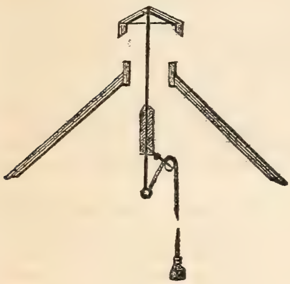


Fig. 12.

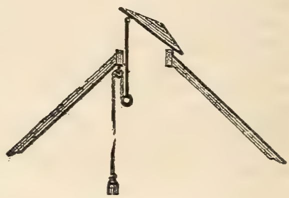


Fig. 13.

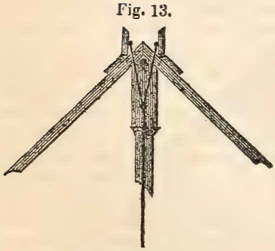


Fig. 14.

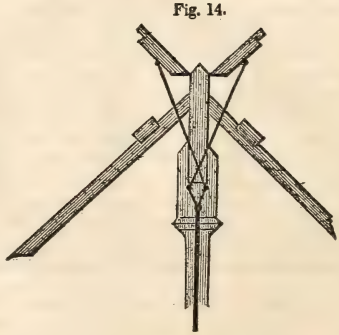


Fig. 15.

Fig. 17.

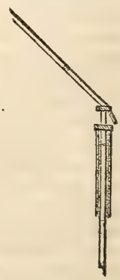


Fig. 16.

Fig. 11 consists of a cap-piece fastened to sliding rods, and opened by raising the cap by means of the rods. Fig. 12 consists of a similar cap-piece, hinged on a frame made by itself and put between the rafters, the hinges being on the side next to the prevalent cold winds, and is opened by rods or other convenient mechanism. Or it may be made of two boards nailed to a roof-shaped batten and hinged as before; or of a single row of glass-lights in a frame of sash, on each side of the ridge of the batten. The latter is the most costly, and it

cannot be said of it, as of the lower ventilation, that the lights of glass do no good ; for the opaque boards at the top cast a shade and it is desirable to avoid this by the use of glass Figs. 13 and 14 represent a cheaper mode of ventilation, made either of plain battened boards or of sash-frames and glass, and opened by the rods, as represented. But it will be found that ventilation represented in figs. 11 and 12 are the best, mainly for another advantage. When the vines have reached the top of the house they are not contented with their growth, but attempt to push on further, and in so doing, despite gentle stoppage, usually cross over, or arch over, and entwine with the opposite vines. In so doing they set full of fruit at the top of the house, and frequently the choicest bunches are ripened at this point. Therefore, it is believed that as the cap ventilation in figs. 11 and 12 can be made broader than is necessary for mere ventilation, and the vines allowed ample room for this arching at the top, it better be given by separating the ends of the rafters, either by the rectangular ventilation frame or a horizontal piece nailed on each pair of rafters. But be this as it may, either of the above forms of ventilation is recommended as having been demonstrated to be amply sufficient, easily managed, durable and sufficiently air and water-tight when well made.

Practically, in making the rafters, they can be set edgeways, as seen in fig. 15, or flatwise, as in fig. 16. It is disputed which admits the most light—a point not now to be settled. If set flatwise, less glass is used, and either way is good enough, and has light enough. Rafters one inch and a quarter thick, and two and a half wide, made of sound pitch-pine, are stout enough, there being three sets of posts to support them—one for the ridge, and one on each side of the ridge, these posts having string-pieces on their top to which the rafters are nailed. Four by four inch posts for the ridge, turned or not, and two and a half inch posts for the sides, are large enough. They should be about six feet apart, and may each have two secondary or adjunct vines trained upon them, which have already been said to bear as well, or nearly so, as the wall wines of lean-to graperies. The common rotary planing machine is convenient to dress the rafters, and the common tenoning machine will cut the grooves represented in fig. 15, and, by removing the lower revolving knife, will cut the glass grooves in fig. 16; and, when to be had, rafters thus made will cost much less than if dressed by hand. Beyond these rafters and posts do not load down the house with the usually-recommended main rafters, nor with vine trellises, as they are perfectly useless, and do injury to the sunlight by their heavy shadows. Nor need there be any other parts than described to sustain the roof, if the roof is as steep as it should be. Ordinary snow will slide or be blown off, or, where it lies on the roof, it is better to put up temporary supports under the roof for the winter, and remove them in the spring. *Main rafters*, *cross bars*, *sliding sash*, *inside vine trellises*, and other cumbrous parts, as well as side *pilasters* above the ventilators, are for the carpenter's bill, not the benefit of the grapery and vines.

Still further to render the vinery within reach of the humblest citizen, a house wholly of wood is here presented in detail. Fig. 17 represents the plan of a grapery twenty-two feet wide, and thirty-six feet long, so far as it differs from fig. 10 ; and the cost, vines, border, and whole structure prudently made, did not exceed one hundred and seventy-five dollars. The soil was naturally as good as could be desired—a rich sandy loam, full of carboniferous matter, on which peaches, pears, apples, and out-door grapes are grown freely. About two feet eight inches below the top of the ground is a bed of very hard, impenetrable clay, which roots cannot pass, over loose gravel thirty feet thick to water. On top of the clay is coarse sand six to eight inches thick, and the clay floor fully equalling a floor of mortar concrete descends to the West, thus drainage and a cement floor were naturally given. First were set oak posts steeped in a solution of sulphate of copper, a pound and a half to twenty gallons of water in a copper tank three feet and a half deep. The posts thus kyanized were set about six feet apart, and on the outside sound pitch pine, tongued and grooved flooring, coated on the sides and edges with coal tar and linseed oil, were nailed, cutting off the passage of the roots of the vines outside of the house. On the inside, from three inches below the surface of the border flooring, coated as above, was nailed up to the ventilators, and the intermediate space below the boards filled with wood, chips of a turning lathe. One foot from the surface of the border is the sill, made of one inch board, capping the flooring just named. Seven inches above this sill the plates, two inches thick, and six inches wide, is spiked on top of the posts, on the outside of which is hung the ventilators on the East, South, and West sides, the door being on the North end, and the flooring continued to the plate on that end. Plate, posts, and everything below the glass, where exposed and where not exposed, was coated with coal tar and linseed oil. At a little less than two feet from the ground the rafters were nailed to the plate, and supported at the ridge by a series of columns turned to resemble the small stout posts which support the upper deck in steamboats, the bottoms of which, as far as set in the ground, were kyanized in the copper tank, and had on their top a string-piece one and a half inch thick, and five wide, set edgeways, and to which the rafters were nailed. The side rows of columns are placed half

way between the ridge and the eaves or plate, and were also kyanized a little further than they set in the ground, having also longitudinal string-pieces on them, to which the middle of the rafters are nailed. The top ventilation is such as is represented in fig. 14. The house has twelve main vines on each side, set when one year old, and twelve alternate vines on each side, set when three months from the eye, with the design of cutting down the main vines to near the roots one year, and the alternate vines to near the roots the next year—a plan of which more is to be said. There are also thirty secondary vines trained up the posts, besides twelve lesser vines at the ends—total, twenty-four main vines, fifteen secondary, and six lesser or end vines, to be fruited each year, besides the alternate vines on which the next year's canes are grown. The glass used is 8 × 10, fourth quality, French, costing a little less than two dollars a box delivered at the grapery. The border should have been divided, but it is not. Lumber, material, work, and fertilizers being reasonable where this was built, the cost is within the reach of any one, and could have been built and furnished complete by contract at two hundred dollars. The border was made after the house was put up, but the glass not set, by digging out the earth in sections to the sand drainage over the clay and mixing in, as it was replaced, five loads of hair and lime from a tannery, which was about two-thirds hair and one-third lime, and three loads of straw and lime, the refuse of steam-bleaching vats of a wrapping paper mill, about half lime and half rotten straw, and six loads of thoroughly-decayed stable manure. This well forked with a natural soil, that would grow any product of the latitude, makes a rich border; and the reader needs no assurance that the vines have done well. Several other graperies near this one attest the virtue of this compost of good soil, tannery, and paper mill refuse, as being clearly not repulsive or expensive, and efficient in beautiful fruit. It is hoped this practical lesson will explain to the reader what is meant by a grapery made of wood and within the reach of every one. If the kyanizing in the copper tank (wood tanks shrink and will not hold the solution) is successful, the posts ought to last thirty years or more. The boarding outside will, of course, need replacing every few years below the ground, which can be easily done from the outside at a very moderate expense, and, unless there should be unusual hail or storm, this rotting of a few feet of boards will be the most repairs for many years, the house in the meantime giving the family its choice fruits, and, by the grapes sold, paying for itself many times over. Let it be remembered that a wood wall requires the level of the border inside of the house, and of the ground or mound outside to be the same, as no wood fence or ordinary wood wall will endure the variation of six inches long where frosts abound.

The copper tank spoken of should be, at least, twenty inches in diameter, round, and about four feet deep. When thus made, it will last for years, and do much service for fence posts, as well as the grapery. Put in as many posts as it will hold, and fill up with the solution as above stated, and let it stand at least three weeks before the posts are taken out. In building after this model, it is recommended first to complete the carpentry to the plate over the ventilators all around the house, setting the door in either the South or North end, and another in the other end, if desired. Then set three rows of columns, and make very true and straight the plates and the longitudinal string-pieces on the tops of the columns. Then nail together on the ground, by a fixed pattern, the rafters, and tack on the bottom of the rafters a temporary tie of stay-lath; raise the pair thus nailed together to its place, and, by means of a wooden guide, the width of the glass, they can at once be nailed to the plate and the string-pieces on the columns. This will save a great deal of climbing up and down, as well as time and expense in making the roof of the house. Another small item, but well worth attention, is to let the rafters be so long as to project over the eaves, and trued by being sawed off to a line, and on the inside fit a piece of inch board from the plate to the glass. This board will answer several purposes: make a tight joint, serve as a good support for the upper edge of the eave-trough, give a firm joint between the glass and tin eave-trough, exclude wet and dirt from the top of the plate, and last, not least, cut off the hiding places of a thousand-and-one large common house spiders and their nets, which, though worthy of a Solomon in his glory, when microscopically examined, are not so admirable in the grapery. A friend suggests a solid triangular plate, the rafters bedded in gains or grooves across it, being liberally coated with coal tar and oil for the same purpose. Another friend suggests that the triangular plate have little mortices cut only one inch in the plate, and the rafters nailed therein, the glass to lap on a board over the plate, which board serves as a conveyance of the water to the eave-trough. It is well for the reader to be aware that there is a difficulty at this point, so that the glass shall not be broken by frost, the water of the roof shall not wet the wood work, and no vacant space be left for insects and dust, and that the whole be as tight and warm as can be.

Attention should he directed to means of preventing the frost from breaking glass. To cover the nails on the tin eave-trough, or otherwise lap so far as to secure a tight joint at this point, allows quite a space for drip-water or rain to get under the glass between the tin or wood and the glass, and the expansion by frost cracks the glass, therefore make the lap

of the glass as small as possible. The smaller the capping of the glass can be made in all parts of the house the better. The sixteenth of an inch, if well done, is sufficient, but never exceed an eighth of an inch.

The description of the graperies already figured has been allowed to run freely into the details, as thereby the principles requisite in them is believed to have been the better explained. The last two correctly limit the vine stump to the two feet between the eaves; suitably expand and steepen the roof, and require the vines and roots to be near the surface and near the sunlight, an essential to the healthy growth of any plant beneath glass; divest the vinery of heavy ornament; throw away the cumbersome rafters and heavy frame work, and bring the cost within the means of every one.

It is unnecessary to attempt the details of the vast variety of graperies that can be planned, with no variations fatal to success from these principles. A few only will be named. A fine series of designs may be made by a heavy stone wall to take the place of the mound recommended directly beneath the vinery walls, or ornamented by stone pilasters, and made hollow to exclude frost, the fine stone base setting off the light, graceful structure on the top. The cross-shaped style can be elaborated into a beautiful series of designs, of which fig. 1, near the commencement of this article, is a sample. This has only a few serious disadvantages when correctly made, which are mainly the corner shadows, and which are in a great measure avoided by the use of roofs at an angle of forty-five degrees, and the two North roofs of the arms of the cross without direct sunlight, which admits of no real correction. Another set of models may be framed by the use of the dome, either on the straight line of double or span roof structures, or the cross form of edifices. The dome can be used for two purposes. The *inside effect* is secured where ample loftiness is desired, vines being put on the periphery and suspended in pots about the dome, with a single tropical tree in the centre, fish-ponds or other luxurious internal adornment, well worth the time and taste of those who fancy the beautiful. The dome may also be sought for *outside* and *distant effect*, and when so may cover the water-tank, and this tank, to occupy usefully the space, may be surrounded with an economical system of pot culture of choice vines. Still more varied may be the application of the true principles of grapery building to the mansion, dwelling, or homestead, as a part of the residence itself. In no respect is good taste more wanting than in these attachments to the house itself. Too often they have high perpendicular sides, small roofs, and wide shadow-casting cornices. It is necessary that a new taste by a set of new designs be made for these appendages to dwellings more in accordance with the laws of Nature. For let one go into too many of these numerous appendages, and he doubtless will see how mournfully the vines stretch up to get rid of the perpendicular surfaces, and how disappointed they appear to find the roof so small. The poor vines fairly beg the mercy of being aided to get to some hole in the roof or sides of the house to escape out of these ill-made prisons. Could a few well-made models be contrasted with these, they might be considered less architecturally ornamented, and less relatively important to the architectural effect of the dwelling, but the sunlight on the roots, the vine expanded on the ample roof, and the loaded clusters of fruit, would attest the consciousness of the vine that it was doing a congenial duty in a far more appropriate place.

When this article was begun it was designed to have added illustrations on this last subject, as well as to furnish several high-wrought designs of graperies, but want of time and illness have prevented the execution. Leaving this for a better opportunity, we will pass to the training of the vine. How shall the roots be treated? It has already been said by no deep six-feet border, but put them in well made shallow borders, not over two feet deep. May the day be long before resort to ground bones, decaying animal flesh, meets the approval of American minds. The vine is a "gross feeder," but for that it should have none of these degrading substances, so often productive by their use in garden vegetables of serious disease. The earthy carboniferous as well as gaseous elements of virgin soil, never having been a part of any animal, much less of the human system, are the only eminently healthful materials, and hence the phosphorus, the lime potash out of mineral quarries, and dissimilar vegetable substances, should be sought Hence, too, the compost stated on a former page of clean hair of cattle mingled with lime, from a tannery; the wheat, oat, and rye straw, containing iron, potash, phosphorus, silex, and other elements direct from the earth, from rain-washed fields, rotted and digested with lime by steam, and also mingled with a moderate quantity of stable manure, has been commended, and is known to be all that a good porous, sandy loam requires to ripen the best bunches of grapes, as has been amply proved by the sale of the fruit of nearly every variety of grapery vine in the New York market the last season, in competition with bunches from other parts of the Union. This is said because it is believed no sympathy should be had in America—the Palestine realization of the idea of abundance, even if it be not *the land* of the world—with the so-called "agriculturist," who would have us adopt before it is needful the Chinese, Japanese, or even English "liquid manures" and "night" composts.

How shall the wood be renewed, or the vine be trained for new wood? On this point

many plans may be found, for which see Loudon's Encyclopedia and other works. One of the best is the growing the first cane half way up the house the first year, and there stopping it, or, what is better, cutting it back to that point in the fall of the first year, and the second year continuing this half cane to the top of the house, and there stopping it, the lower half in the meantime bearing fruit, and at the same time training a new one from at or near the roots to the middle of the house, as was done with the first cane the first year. The third year fruit the top of the first cane, and also the lower half of the second, and growing a new one from at or near the ground to the middle of the house, and also completing the second to the ridge of the house, and in the fall cutting down to the ground or stump the whole of the first cane, after which the system is fully established, and the rotation, it is said, can be fully kept up. Now, were it possible to be always successful by this plan, no better need be devised, but practically the sun does not shine any two years alike, the vine, like human energy, cannot be forced in the same way at all times, and the vinedresser cannot always judge correctly, and it will not answer. It is too laborious and uncertain. The spur system is a good one—that is, one main cane or vine from each root, and buds or spurs grown out of it about a foot apart, each year producing both fruit and leaves. Cut back the spurs each year. This practically succeeds tolerably well a few years; but both native and foreign vinedressers agree that however European vines may succeed, it is nearly or quite a failure in this country.

The beginner will find the following to be his experience. He completes his grapery, and sets out his one or two year old roots, cut down to one or two eyes or buds, and with the charm of novelty watches the fine growth of the first year. With reluctant hands he cuts down the vines to within four eyes or buds of the ground in the fall. The second year he ripens one or two fine clusters from the four eyes left, much to his admiration, and in the meantime from beneath or near the soil a stout cane or vine from each root has grown up beyond the middle of the roof, and has reached the ridge, been stopped there, and ripened according to his wishes. These, as winter comes on, he lays down and covers with pieces of old carpet, if the thermometer goes below the zero of Fahrenheit in his latitude, otherwise he merely lays them on the ground. The third spring he raises them a foot or two, washes them, and begins to water and force them, leaving them thus horizontal until the young leaves are out and the bunches formed, but not opened. He now ties them to his rafters, and, putting on a high heat, with much water, and a steaming damp air, is delighted as the bunches open and blossom, when he admits, on a few fine sunny days, coming just now, plenty of air, to cause the pollen to circulate and set freely his fruit. Nothing can be more charming, the fruit sets, he moderates his heat and humidity, and time rolls on a space, when the thinning of the bunches, a seeming cruelty, must be done. He cuts off one-half or two-thirds of his fruit, leaving only as much to ripen as his yet young vines can mature. He sees the thinned ranks fill up by size and fairness, so that he does not miss the bunches and the berries, that a while ago lay strewn on the border, by his unsparing scissors. At last the grapery is full of the massive bunches, a sight amply repaying him for his toil and expense, congratulated by his numerous visiting friends, happy in his success. But exactly as he has gathered this first crop comes a very perplexing question. How shall this resplendent scene be re-enacted? and the reply is not easy. For a year or two the spur system will repeat it. Other modes are not successful, or are too cumbersome.

At this point comes in a plan on which many have stumbled, and which has even been often suggested and acted on, but which, with a boldness, admirable freshness, and energy worthy the cause, is recommended by William Bright, esq., of Philadelphia. So successful a culturist of the vine, speaks with authority when he suggests and advises, and therefore his book is commended and should be read. His plan is to plant a double series of vines. The first or main row is the same as on the old plan, set at such distances apart as will suit the views of the owner of the vinery, say two to four feet, averaging three feet. Between each of these are planted the second or *alternate* row of vines, one year younger than the main vines. He then fruits the main vines one year, and cuts them down to the stump or near the ground, and the next year fruits the alternates, growing no fruit but a new and stout trunk or vine from the main stump. Thus he rotates the bearing and the renewal of the vines or canes year after year.

Practically the system is commenced by setting out one year old vines as *main vines* as soon as the vinery is completed, and at the same time the *alternate vines*, which are eyes or buds, just stated. Both main and alternates are cut down in the fall, but an eye or two of the main roots are left to be fruited as tests of the vines. The second year the main vines fruit the one or two test-bunches, and throw a fine cane or vine to the ridge of the roof. In the fall of the second year the main canes are laid down and the alternates cut down to the four eyes, near the ground. The third year the main vines give the first full crop, and the alternate vines grow a stout cane or vine to the ridge. In the fall of the third year the main canes are cut down to the stump near the ground, and the alternates spared and laid

down. The fourth year the alternates bear their first crop of full fruit, and the main vines renew their canes ; and so on until, by age or exhaustion of the border, the vines, roots, and soil or border need to be replaced.

This plan commends itself to every grape grower. It is simple and effectual. By fruiting each vine only every other year, vigor of the vines and richness of fruit unequalled are produced. We know of no system so well calculated for the grapery as this ; and for out-door vines it is eminently adapted to correct the slovenly negligence too commonly seen, that allows a vine to ramble at pleasure over the tops of arbors, trees, trellises, and the dwelling roofs of our citizens, giving a large quantity of half-ripened fruit, in place of the choice lesser quantity to each vine, but more fruit to the same space, of the radical thoroughness implied by this plan.

Mr. Bright further recommends the border to be divided, which is a just and reasonable idea, but whether absolutely essential to his system remains to be seen ; also that air be circulated beneath the border. This is also radically to correct an evil, and probably to be approved. He accomplishes this by concreting or cementing the bottom of his excavation—a thing long done—and laying in mortar, on the concrete, bricks on their sides, and over these bricks laid sidewise he puts bricks flatwise, so as to let the drainage be through them into the air chambers thus formed below. These air chambers he continues up the sides of the border, between the border and the walls of the house. This admits the warm air of the house to the chambers below the borders, and thus the stimulus of a heated border is given to the vines. The divisions of the border he makes by placing on the drainage bricks laid flatwise, walls to separate the roots of the vines, made of bricks laid sidewise, and carried up two feet, or to the top of the border. This, in fact, as he says, is putting each vine in a large pot containing many cubic feet. It is best, however, not to limit the roots, as he does, a few feet from the vine towards the centre of the house, but let them run to the centre, and there separate them from the roots of the opposite side by a longitudinal wall through the whole length of the house, and that the secondary, or vines grown up the posts, be in pots.

Though the detail must be omitted here, Mr. Bright's *pot culture* is to be commended, and when the writer's experience with his one hundred pots shall be obtained, he hopes to give the Patent Office the results, if of value.

For the further training of the vine, the best plans of heating, the care of the vines, and other details, requiring much thought and space, the reader is referred to manuals, to periodicals, and other publications on the subject.

The diseases of the vine are few beyond mildew. There is a damp, cold mildew, corrected by air and artificial heat; there is a hot and damp mildew, corrected by sulphur, cold, and dryness. Both deserve attention ; and, if they come, must have it, or the fruit is lost.

The insects that have been observed by the writer are mainly two. A green bug, with a triangular-shaped back and light green wings, stops the vines at night, when there is the least desire it should be done, by eating off their leading bud or shoot, and may thus cause part of the best weeks of the year to be lost. The red spider is another pest. The novice, when he hears of spider, will look for a tangible, crawling one of some size ; but this spider appears like ten thousand points, as small as if made by the touch of a delicate needle point on the leaves. A magnifying glass shows a whole army of them encamped on the leaf. A damp, hot air, or a hot, damp, sulphured air, causes the myriads to vanish. If let alone, the leaves lose their color and turn yellow and die, and consequently the vine droops.

There are various kinds of heating flues, iron pipes, hot water and steam boilers, and other heating apparatus, which, however, have not been figured in this article. It ought to be said that the best plan of artificial forcing is to commence the fires on the 1st of February or March, so as to have only *six* or *eight* weeks in which the fire is to be maintained ; and that if, by a *month's* firing, the fruit can be got to ripen a month earlier, the grower will command better prices than to ripen later and sell his crop in competition with fall fruits and out-door grapes. The cold vinery, not forced at all, or a vinery forced only a few weeks, is all that can be recommended, and this can be done as well by common stoves and stovepipes as by the better but more costly brick flues. No remarks have been made here on the varieties of grapes, because every book speaks of them. Without particularly detailing the mode of attaching vines to the roof, wires parallel to the rafters, six to ten inches below the glass, are the best modes, or even nails in the rafters and strings about a foot apart. Much might be said too on water tanks, pump, and hose, watering the leaves and fruit by a fine jet ; how to wet the vine roots, an important matter ; but there is now no space for detail, and it requires only common sense to be understood. Dry borders, so often mentioned, does not mean to dry up the border and vine, but only that, while watering freely, no superfluity can remain in them. Mildew is checked wonderfully by sulphur scattered dry and mingled in the water used. There should be an examination, and if it is "dry, hot mildew," it needs water, sulphur, and coolness ; if "damp, cold mildew," it is corrected

by heat, sulphur, and dryness. Mildew usually comes *early*, mainly in consequence of the change from the hot, damp air and excessive forcing in setting the fruit to the colder air and moderate growth of swelling the fruit, which change, if too violent, will fill the house with this destructive disease. It comes later, by another violent change, when the watering is stopped and a dry, hot air is created for ripening the fruit and giving it high color and flavor.

THE FORESTS AND TREES OF NORTHERN AMERICA, AS CONNECTED WITH CLIMATE AND AGRICULTURE.

BY J. G. COOPER, M. D., HOBOKEN, NEW JERSEY.

The following attempt to point out some of the chief Characteristics of the vast Forests and no less vast Plains in our country, with their importance in connexion with Agriculture, has been suggested by numerous circumstances, having such a bearing, brought under the writer's own observation during journeys through nearly all the regions of the United States, as well as the careful study of the observations of others, for the purpose of preparing exact Maps of the Distribution of our Trees.

Since the publication of a Preliminary Catalogue and brief article on the subject of their Distribution in the Smithsonian Report for 1858, many new facts have been collected, some of which are included in this paper.

In studying this subject it seems most proper to commence with those regions which have few or no trees, the coldness of the climate wholly forbidding their growth, as well as the cultivation of nutritious plants, and thence to advance to those that are more richly wooded, and which produce every useful plant suited for cultivation in the temperate zone.

For a number of degrees around the North pole the amount of heat is insufficient for the growth of those plants which tend to become trees. The Line of Limitation is remarkably distinct, and the commencement of forests usually so sudden and uniform in its position as to indicate a fixed law of temperature as its cause. It does not form a circle with the pole as its centre, but a three-sided area with rounded corners, the most Northern side reaching to about latitude 70° in Norway and Siberia, near the level of the Arctic sea, while on the Western continent the limit descends from the Arctic circle, 69° 30′ at Behring's Straits, in a nearly direct line, to latitude 60° at Hudson's Bay, and, crossing Labrador in about the same parallel, strikes over the Atlantic South of Greenland, entirely excluding that large country and Iceland from the regions of tree growth. These limits will be further considered in treating of their climatological relations.

As all the trees found along this boundary are also met with in the United States, as well as the others which do not reach to this limit in British America, they are here briefly enumerated in the order of their occurrence, showing that their range, as far as known, usually corresponds nearly with the direction of this extreme Northern limit.

TREES OF THE LACUSTRIAN PROVINCE.

Dr. Richardson* tells us that at the mouth of the Mackenzie's river, latitude 68°, the following trees occur, generally dwarfed, but many showing, by their annual rings, a very great age:

Ath. 58c. *Betula papyracea*, Paper birch.
Ath. 59a. *Alnus incana*, (*E. b.*,) Speckled alder.
Ath. 59b. *A. viridis*, (*E. C.*,) Green alder.
Ath. 60b. *Salix lucida*, Northern willow.
Ath. 61a. *Populus tremuloides*, Amer. Aspen poplar.
Ath. 61g. *P. balsamifera*, Balsam poplar, Tacamahac.
Ath. 63a. *Abies alba*, White spruce.
Ath. 68b. *Juniperus communis*, (*E. C.*,) Northern juniper.

The numbers are those used in the catalogue of North American trees published in the Smithsonian Report for 1858. The region where the tree is believed to be most abundant is indicated by the abreviated name prefixed, as Ath. for Athabascan, the region between the Rocky mountains and Hudson's Bay.

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* Expeditions in search of Sir John Franklin.

Further South on Mackenzie's river the following are met with at the Arctic circle, 67° 30′:

Ath. 21b. *Cerasus Virginiana*, Choke cherry.
Ath. 62a. *Pinus Banksiana*, Gray Scrub pine.

At latitude 65°:

Ath. 24. *Amelanchier Canadensis var. a ? alnifolia*, Service berry.

Alg. 63c. *Abies nigra*, Black spruce.
Ath. 64a. *Larix Americana*, Larch Tamarack.

At latitude 62°:

Alg. 63d. *Abies balsamea*, Amer. balsam fir.

Alg. indicates that the tree abounds most in the Algonquin region, East of Hudson's bay and North of latitude 50°.

At latitude 59° he found:

W ? 21c. *Cerasus serotina ?* Black wild cherry.
Ath. 22c. *Pyrus Americana*, Amer. mountain ash.

And at latitude 56° 30′: C. 62d. *Pinus resinosa*, Red or "Norway" pine.

W ? denotes that the tree met with may have been one of the species prevailing West of the Rocky mountains, as the above named is generally more Southern in its range.

Those of the above which reach the limit of trees at latitude 60° in Labrador are: 58b 59(?) 60(b?) 61a, 21b, 68b, 64a, 63e, 63d, 22c.*

Crossing from the basin of the Mackenzie to that of the Saskatchewan, about latitude 54°, the following make their appearance:

O. 6b. *Rhus glabra*, Smooth sumach.
O. 11a. *Negundo aceroides*, Box elder.
C. 21a. *Cerasus Pennsylvanica*, Red wild cherry.
C. 42a. *Fraxinus Americana*, White ash.
C. 42d. *F. sambucifolia*, Black or Water ash.
C. 45b. *Ulmus Americana*, White or Weeping elm.
O. 45c.? *U. racemosa*, Northern corky elm.
C. 53a. *Quercus rubra, var.? ambigua*, Gray oak.
Alg. 65a. *Thuja Occidentalis*, Canadian Arbor vitæ.
All. 68a. *Juniperus Virginiana*, Red cedar or Juniper.
Alg. 69a. *Taxus Canadensis*, Can. Yew; Ground hemlock.

In this list All. is for Alleghany and O. for Ohio, the regions East and West of the Alleghany mountains, Southward of latitude 43°. C. means Canadian, the Region between latitude 43° and 50° to 54°, to be again alluded to.†

At the South end of Lake Winipeg, about latitude 50°, are first met:

C.? 7a. *Tilia Americana*, Linden basswood.
C. 10a. *Acer saccharinum*, Sugar maple.
All. 10d. *A. rubrum*, Red maple.
C. 10e. *A. Pennsylvanicum*, Moosewood; Striped maple.
C. 10k. *A. spicatum*, Mountain maple.
O. 20a. *Prunus Americana*, Northern wild plum.
O. 53e. *Quercus obtusiloba*, Post or Iron oak.
All. 53b. *Q. alba*, White oak.
C. 55a. *Tagus ferruginea*, Northern or Red beach.
C. 57. *Ostrya virginica*, Hop hornbeam, Leverwood.
All. 61h. *Populus, var.? eaordicans*, Balm of Gilead poplar.
C. 62j. *Pinus strobus*, White pine.

Further East in the basin of the St. Lawrence and lakes the following species are added occurring in the order here given in coming Eastward:

O. 63c. *Abies Canadensis*, Hemlock spruce.
O. 53a. *Quercus macrocarpa*, Burr or Overcup oak.
Alg. 58d. *Betula excelsa*, Yellow birch.
All. 58c. *B. nigra*, Black birch.
All. 58c. *B. lenta*, Cherry or Sweet birch.
All. 58a. *B. populifolia*, White Oldfield birch.
C. 61b. *Populus grandidentata*, Soft aspen poplar.

* G. Cartwright's Journal of 16 Years' Residence on the Coast of Labrador. Newark, (Eng.,) 1792, III, p. 223

† Richardson mentions others occurring on this route, which will be hereafte spoken of.

Along the Atlantic the Northward range of all the above is about two degrees further South, in New Foundland,* Nova Scotia,† and Canada East, omitting 11a and 53a, which do not extend East of Ottawa or Sorel, branches of the St. Lawrence.

Of the above 46 species of trees, 59a, 59b, 60b, 61g, 68b, 62d, are within the Eastern United States, limited to the Alleghany range of mountains, North of latitude 43°. Of the others only 11a, 10d, 68a, extend their range South of the end of the Alleghany uplands, about latitude 34°; and 58b, 61a, 63a, 63e, 63d, 64a, 22c, 69a, 10c, 10k, 62j, 63e, are confined to the higher mountains, becoming scarce South of latitude 38°.

It thus appears that the forests of the Alleghanies are, in great measure, merely spurs of the more extensive forests of the same trees North of the United States, covering the Athabascan, Algonquin, and Canadian Regions;‡ while we also find that all their characteristic trees (indicated by the letters prefixed to the names) become more and more scarce towards the South within the United States. From the above facts, these Northern forest-clad regions, with the higher Alleghanies as a branch, may be considered as forming a Natural Province especially adapted to the growth of a large number of trees which have spread so as to cover the whole surface, except some limited tracts too marshy or rocky for them.

This Province, called from the large number and size of its lakes the Lacustrian, thus extends from the Rocky mountains East to the coast of Labrador, and from the Northern limit of forests South to latitude 43° *at or near the level of the sea*, the Alleghanies forming an extension of it towards the South.

But West of Lake Erie another circumstance enters to limit it on the Southwest, namely, the commencement of the Prairie country, where most of the characteristic trees cease to appear.

The line marking this boundary curves gradually from West to Northwest, commencing at the West end of Lake Erie, and on reaching Lake Winipeg pursues a Northwest direction to the base of the Rocky mountains, about latitude 60°.

The subdivision of this Province into three Regions, characterized by the prevalence of certain trees, seems warranted by the facts of distribution just given. The Canadian, embracing its more Southern part, has fifteen species reaching their highest development and abundance within it. Its Northern boundary is from the Saskatchewan basin, near the forks of that river, to Lake Superior, and thence East to the Gulf of St. Lawrence, including New-Foundland. It thus includes all the Northern side of the St. Lawrence basin, and its South side, excepting the Southern shores of Lakes Michigan and Erie.

The Algonquin and Athabascan Regions lying North of this on the East and West sides of Hudson's bay seem to differ in their relative proportions of the remaining seventeen *common* trees of the Province; but in referring thirteen of them to the latter and five to the former, I only show the present testimony in the case, without intending to state these as the kinds actually most prevalent. This Province has then 32 characteristic trees, and 13 others skirting its Southwestern borders. Besides these, 5, 6a, 6c, 10e, 18, 23a, 23c, 23e, 25a, nine more cross its Southeastern borders, as mentioned in a succeeding list.

TREES OF THE APPALACHIAN PROVINCE.

By this name I intend to designate all that part of the Atlantic States South of latitude 43° and *East* of the border of the Prairies, which, commencing at the West end of Lake Erie, forms a curve nearly parallel to the Atlantic coast, and ends at the Southwest corner of Louisiana. All this was originally covered by a dense forest of remarkable richness both in the variety and beauty of its trees—in this respect surpassing any other part of the temperate and even many parts of the tropical zone.

Though there is no very distinct line by which to divide this into two Provinces, as might be considered warranted by the great number of trees it possesses, yet a general subdivision into the *uplands* and the *lowlands* is very perceptible, the latter embracing the sandy seaboard, pine barrens of the South, and swamps of the lower Mississippi valley. These each include three Regions, whose borders cannot be very definitely laid down, but having evidently each its characteristic trees. They are briefly:

1. The Alleghanian, (d,) comprising the Eastern slopes of the uplands and lower Alleghanies, terminating in a point at latitude 34° in Georgia.
2. The Ohio, (e,) including the Eastern uplands of the Ohio valley, East of the Prairie border and North of latitude 38°.
3. The Tennessee Region, (f. f.) embracing all the remaining uplands, the Southern slopes of the Alleghany hills facing the Gulf of Mexico, and the Ozark mountains or wooded tableland bordering the West side of the lower Mississippi valley.
4. The *Carolina* Region, (g,) bordering the Atlantic coast, between the Alleghanies and the

* Bonnycastle's History of New Foundland, 1842, I, 289, and Juke's Physical Geography of New Foundland, 1849, II, 212.

† Gesner's Industrial Resources of Nova Scotia, Hal., 1849.

‡ Marked on the Map as a, b, c.

ocean, from Middle Georgia, North to Long Island, and with scattered outspurs as far as the coast of Maine.

5. The *Mississippi* Region, (h,) or the lowlands bordering the Gulf of Mexico, from Middle Georgia to Texas, and extending up the lower Mississippi and branches to lat. 38°.

6. The *Florida* Region, (i,) including most of the State of Florida, or all South of lat. 30°

Very near lat. 43° on the uplands, near the Atlantic coast, the following trees are first met with, namely, in Maine:

All. 30. *Kalmia latifolia*,
Mountain laurel.*
All. 31a. *Rhododendron maximum*,
Great laurel.
All. 42c. *Fraxinus viridis*,
Green ash.
O. 50a. *Platanus Occidentalis*,
Buttonwood; Sycamore.
All. 51a. *Juglans cinerea*,
Butternut; Oilnut.
All. 53g. *Quercus castanea*,
Chestnut oak.
All. 53r. *Q. tinctoria*,
Black oak; Quercitron.
All. 54a. *Castanea Americana*,
Chestnut.
All. 62f. *Pinus rigida*,
Northern Pitch pine.

In New Hampshire:

O. 44. *Sassafras officinalis*,
Sassafras.
All. 52b. *Carya alba*,
Shell-bark hickory.
All. 52d. *C. tomentosa*,
Mocker-nut hickory.
O? 52f. C. glabra,
Pignut or Broom hickory.
O? 53f. *Quercus, var. ? discolor*,
Swamp white oak.
All.? 53h. *Q. var. ? monticola*,
Rock chestnut oak.

In Vermont:

Tenn. 9a. *Vitis labrusca*,
Northern fox grape.
O. 9c. *V. aestivalis*,
Summer grape.
O. 9d. *V. cordifolia*,
Winter or Frost grape.
T. 25b. *Cornus florida*,
Flowering dogwood.
A.? 42b. *Fraxinus pubescens*,
Red ash.
(O. 45c. *Ulmus racemosa*,
Northern corky elm.†)
O.? 47a. *Celtis Occidentalis*,
Northern hackberry.
O. 49a. *Morus rubra*,
American mulberry.
T. 52g. *Carya amara*,
Bitter or Swamp hickory.
All. 60a. *Salix nigra*,
Black willow.
O. 61e. *Populus, var ? Canadensis*,
Canadian poplar.
All. 63b. *Abies Fraseri*,
Southern balsam fir.

Of these, numbers 30, 31a, 42c, 63c, do not extend West of the Alleghany range, but several others appear in their place in New York and the Southern borders of Canada.

In New York:

T. 1b. *Magnolia acuminata*,
Cucumber tree.
T. 3a. *Asimina triloba*,
Pawpaw, Custard apple.
O. 22a. *Pyrus coronaria*,
Western Crab-apple.
(O. 53a. *Quercus macrocarpa*,
Overcup, or Burr oak.)

In Canada:

T. 5. *Ptelea trifoliata*,
Trefoil tree.
All. 6a. *Rhus typhina*,
Velvet sumach.
M? 6c. *R. venenata*,
Poison sumach.
O. 10c. *Acer dasycarpum*,
White or Soft maple.
O. 18 *Gymnocladus Canadensis*,
Coffee-bean tree.
O. 23a. *Crataegus crus-galli*,
Cockspur hawthorn.
O. 23c. *C. coccinea*,
White hawthorn.
O. 23e. *C. tomentosa*,
Downy-leaved hawthorn.
All.? 25a. *Cornus alternifolia*,
Green dogwood.

And in Michigan (somewhat doubtfully):

O. 42e. *Fraxinus quadrangulata*, Blue ash.

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* The unreliability of popular names is shown by the very distinct plants confounded under the name "Laurel," which led Blodgett into one of the many scientific inaccuracies of his chapter on "Climatological range of forests." On page 412, near the bottom, he confounds the *Kalmia* with *Magnolia grandiflora* of the South! quoting some vague authority on the distribution of our "Laurels." At least five other very distinct trees of this country are locally known by this name, while all are distinct from the true Laurel of Europe, one only (82 of Catalist) being even of the same family of plants.

† Those names in parenthesis have been before given, but are repeated to show the difference in the North-Eastern range.

It thus seems that the Alleghanies in this latitude form a good line of division between forms characteristic of the Regions on their opposite sides; for even the two marked "All." in the last list are more common on their East side a little more Southward.

Proceeding Southward along the uplands many are added, at intervals, to the list.

In Massachusetts:

T. 2. *Liriodendron tulipifera*,
Tuly's tree; "Poplar."
O? 4a. *Zanthoxylum Americanum*,
Northern prickly ash.
A. 10b. *Acer, var ? nigrum*,
Black sugar maple.
(T. 53c. *Quercus obtusiloba*,
Post oak; Iron oak.)
O? 53s. *Q. coccinea*,
Scarlet oak.
O? 53g. *Q. palustris*,
Pin or Swamp oak.
T. 62e. *Pinus mitis*,
Yellow or Spruce pine.

In Pennsylvania and the uplands of New Jersey:

T. 1c. *Magnolia umbrella*,
Umbrella tree.
T. 1d. *M. Fraseri*,
Ear-leaved magnolia.
(O. 11a. *Negundo aceroides*,
Box elder.)
O. 12a. *Aesculus glabra*,
Ohio buckeye.
T. 15a. *Robinia pseudacacia*,
Common locust tree.
O. 17a. *Cercis Canadensis*,
Red bud.
T. 19a. *Gleditschia triacanthos*,
Honey locust.
A. 22b. *Pyrus angustifolia*,
Narrow-leaved crab apple.
T. 32. *Oxydendrum arboreum*,
Lousewood; Sorel tree.
All. 41. *Chionanthus Virginica*,
Fringe tree.
T. 52c. *Carya sulcata*,
Thick shell-bark hickory.
T. 53j. *Quercus imbricaria*,
Laurel or Shingle oak.
T. 55b. *Tagus, var ? alba (sylvestris,*)*
White or Southern beech.
A. 62b. *Pinus inops*,
Jersey scrub pine.

On the uplands of Maryland and Virginia:

A. 15b. *Robinia viscosa*,
Sticky locust tree.
T. 23j. *Crataegus cordata*,
Washington hawthorn.
T. 38a. *Halesia tetraptera*,
Silver-bell tree.
A. 62c. *Pinus pungens*,
Table mountain pine.

Finally limited to the most Southern and Western Alleghanies (Tennessee Region:)

T. 1f. *Magnolia macrophylla*,
Large-leaved magnolia.
T. 12b. *Aesculus macrostachya*,
Eatable buckeye.
T. 16. *Cladrastis tinctoria*,
Yellow wood.
T. 38b. *Halesia diptera*,
Two-winged bell tree.
T. 6d. *Rhus cotinoides*,
Amer. smoke tree.
T. 45e. *Ulmus crassifolia*,
Thick-leaved elm.
T. 48. *Maclura aurantiaca*,
Osage orange.

The first four grow naturally only East, and the last two only West of the Mississippi, as far as is now known, and thus being peculiar to the Region.

Of these lists, 1b, 3a, 22a, 53a, 5, 18, 1c, 11a, 12a, 17a, 52c, 53j, are very scarce or unknown on the Eastern side of the mountains, (Alleghany Region,) while 60a, 63b, 62e, 22b, 41, 62b, 62c, seem equally rare West of it, and are therefore its most peculiar trees.

Only 45c, 42e, can be considered as nearly *peculiar* to the Ohio Region.

Coming to the sandy lowland Regions of the Atlantic and Gulf coasts:

Even in Maine there may be found two straggling species in very small numbers, viz:

C. 33a. *Ilex opaca*,
Amer. holly.
C. 61c. *Populus heterophylla*,
Downy-leaved poplar.

In New Hampshire, near lat. 43°:

M. 26. *Liquidambar styraciflua*,
Sweet gum.
C. 27a. *Nyssa multiflora*,
Pepperidge; Sour gum.

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* Falba Rafinesque; sylvestria being too near sylvatica of Europe.

In Massachusetts:

C. 1a. *Magnolia glauca*,
Sweet bay magnolia.
C. 34a. *Diospyros Virginiana*,
Persimmon.
M. 61f. *Populus angulata*,
Southern cottonwood.
C. 66a. *Cupressus thyoides*,
Southern white cedar.

In Southern New Jersey and the adjoining corner of Pennsylvania along the Delaware river:

M. 7b. *Tilia heterophylla*,
Southern linden
M. 12c. *Aesculus Pavia*,
Smooth buckeye.
M. 12d. *Ae. flava*,
Yellow buckeye.
M. 47b. *Celtis, var? Mississippiensis*,
"Hoop ash," or hackberry.
M. 52c. *Carya microcarpa*,
Water hickory.
M. 53e. *Quercus prinus*,
Swamp chestnut oak.
C. 53k. *Q. phellos*,
Willow oak.
C. 53n. *Q. nigra*,
Black-jack oak.
C? 53q. *Q. falcata*,
Spanish oak.
C. 54b. *Castanea pumila*,
Chinquapin.

In Delaware and the low country of Maryland, near latitude 38° 30′:

C. 9b. *Vitis vulpina*,
Southern foxgrape.
C. 43a. *Persea Carolinensis*,
Red bay.
C. 62h. *Pinus taeda*,
Loblolly pine.
M. 6? *Taxodium distichum*,
Bald cypress.
M. 92. *Arundinaria macrosperma*,
Giant cane.

In the low country of Virginia occur:

C. 8a. *Gordonia lasianthus*,
Loblolly bay.
M? 23g. *Crataegus arborescens*,
Tree hawthorn.
C? 23h. *C. aprifolia*,
Cut-leaved hawthorn.
C. 23l, *C. flava*,
Yellow-berried hawthorn.
M. 37. *Symplocos tinctoria*,
Sweet-leaf; Horse-sugar.
M. 40. *Olea Americana*,
Devil wood.
M. 42f. *Fraxinus platycarpa*,
Southern swamp ash.
M. 45d. *Ulmus alata*,
Southern corky elm.
F. 53i. *Quercus virens*,
Live oak.
M. 53m. *Q. aquatica*,
Water oak.
M. 62i. *Pinus palustris*,
Long-leaved pine.

In North Carolina:

F. 1h. *Magnolia grandiflora*,
Evergreen magnolia.
M. 13a. *Frangula Caroliniana*,
Southern buckthorn.
M. 21d. *Cerasus Caroliniana*,
Evergreen cherry; Laurel.
M. 53d. *Quercus lyrata*,
Southern overcup oak.
C. 60c. *Salix subvillosa*,
Downy-leaved willow.
F. 71. *Chamaerops palmetto*,
Tree palmetto.

In South Carolina:

C. 1e. *Magnolia, var ? pyramidata*,
Pyramid magnolia.
C. 4b. *Zanthoxylum Carolinianum*,
Southern prickly ash.
M. 19b. *Gleditschia monosperma*,
Water locust.
M. 23i. *Crataegus aestivalis*,
Summer hawthorn.
M. 27b. *Nyssa uniflora*,
Southern tupelo.
C. 28. *Sapindus marginatus*,
Soap-berry; "wild china."
C. 29. *Cyrilla racemiflora*,
Carolina ironwood.
M? 36a. *Bumelia lycioides*,
Buckthorn bumelia.
M. 36b. *B. lanuginosa*,
Rusty bumelia.
C? 36c. *B. tenax*,
Silvery bumelia.
M? 52h. *Carya, var. myrioticaeformis*,
Nutmeg hickory.
C. 53l. *Quercus cinerea*,
Upland willow oak.
C. 62g. *Pinus, var? serotina*,
Pond pine.

Of the preceding 54 species of the Lowland Regions, 66a, 23l, 33b, 60c, 29, 62g, do not, as far as now known, extend West of the Savannah river, thus being *peculiar* to the Carolina region; stragglers of the first only *being reported* to grow in Canada and Ohio, where, however, 65a is very often mistaken for it. (See list of latitude 54° and of Pacific side.)

Along or near the Savannah river, in lower Georgia, may be found:

M? 1g. *Magnolia cordata*, Heart-leaved magnolia.
M? 8b. *Gordonia pubescens*, Franklinia; Bay.
M. 14. *Cliftonia ligustrina*, Buckwheat tree.
M. 20b. *Prunus Chickasa*, Chickasaw plum.
M. 27c. *Nyssa, var? coccinea*,* Red Tupelo; Ogeechee lime.
M? 35. *Catalpa bignonioides*, Catalpa; Indian bean.
F? 39. *Pinckneya pubens*, Georgia bark.
M. 46. *Planora aquatica*, Planer tree.

Further West, near the Gulf and the Mississippi river, the following successively occur:

M. 52a. *Carya olivaeformis*, Pecan-nut.
M. 23k. *Crataegus berberifolia*, Barberry-leaved hawthorn.
M. 47c. *Celtis, var? integrifolia*, Whole-leaved hackberry.

These three, with numbers 14, 20b, 27c, 35, 46, seem nearly or quite *peculiar* to the Mississippi Region, though 20b and 52a also extend some distance into Texas, as will be hereafter noticed; 8b and 39 are as yet known only as occurring on the borders of Georgia and Florida, and may hereafter be found rather peculiar to the latter Region.

In the Mississippi valley 34a, 61f, 53n, 52a, extend North to latitude 40° 20′ in Illinois; none of the rest above latitude 38°; 33a, 12c, 53k, 54b, 62h, 42f, 53m, 13a, 21d, 53d, 4b, 27b, 28i, 52h, 27c, 47b, do not reach latitude 35°; 1a, 53k, 43a, 8a, 23g, 40, 53i, 62i, 1h, 71, 1e, 23i, 53l, 14, 23k, are not known to grow as far up the valley as latitude 33°. Deducting these 34, and ten or eleven others confined to the Carolina region and Georgia, leaves 18 which *are known* to have their Northern limit near the mouth of the Ohio river, in Kentucky, Missouri, or Illinois, viz: 26, 27a, 7b, 12d, 52e, 47b, 53e, 53q, 9b, 67, 72, 37, 45d, 19b, 36b, 20b, 35, 46. Except the last five, all of these range as far North on the Atlantic coast, and the first eight from two to five degrees further. The exceptions are the three last, confined to the Mississippi Region, and the two preceding them, whose Northeastern range is perhaps not positively established.

With regard to the two other lists, some will probably yet be found higher up the Mississippi, especially 1a, 47b, 53k, 54b, 43a, 23g, 23h, 40, 62i.

THE FLORIDA REGION.

One tree as yet found only at Apalachicola, Florida, might be referred either to the Mississippi or Florida Region, viz: 70a, *Torreya taxifolia*, Florida Torreya, also called there "Stinking cedar." Its range will probably be found to extend into the peninsula, and it will then be one of the *peculiar* species of the Florida Region.

Four trees of the preceding lists have been marked F., as being most abundant and highly developed on this peninsula. One of them, 39, is nearly peculiar to it, and 8b, of the Mississippi (?) Region, may yet be found so.

Further South are found the following, near or at New Smyrna, lat. 28° 54′, on the East coast:

98a. *Acacia latisiliqua*, Broad-pod acacia.
F ? 100. *Psidium buxifolium*, Box-leaved guava.
102a. *Eugenia latifolia*,† Forked eugenia.
105. *Laguncularia racemosa*, White mangrove.
106. *Papaya vulgaris*, True papaw.
107. *Rhizophora Americana*, American mangrove.

About latitude 28°:

F. 108. *Ardisia Pickeringii*, Florida ardisia.
113a. *Coccoloba uvifera*, Sea-side grape.
132. *Chrysobalanus icaco*, Cocoa plum.

**N. coccinea*, Bartram Travels, 14; *capitata*, Mich.

† *Myrtus? latifolia*, Bartram Travels, 1774, *dichotoma*, D. C.

Between this point and Fort Dallas, lat. 25° 55′, the following occur at uncertain limits:

3b. *Anona laurifolia*,
Laurel-leaved custard apple.
4c. *Zanthoxylum pterota*,
Wing-leaved prickly ash.
6e. *Rhus metopium*,
Broad-leaved poison sumach.
36g. *Bumelia mastichodendron*,
Mastic plum bumelia.
43b. *Persea*, (undetermined,)
White bay.
91. *Simaruba glauca*,
Bitter wood.
95. *Burera gummifera*,
"Gum Elemitsee." (?)
96. *Ximenia Americana*.
97. *Piscidia erythrina*,
Jamaica "dogwood."
102b. *Eugenia procera*,
Branching eugenia.
102c. *E. buxifolia*,
Box-leaved eugenia.
110a. *Cordia sebestena*.
111b. *Crescentia*, (undetermined,)
Seven-year apple.
113b. *Coccoloba Floridana*,*
Pigeon plum.
117b. *Ficus brevifolia*.
Short-leaved fig.
117c. *F. aurea*,
Golden fig.

Of these lists only one is known to be peculiarly Floridian, viz: 108 ; the rest are widely distributed in the tropics of America.

102, 105, 107, 113, 132, 3b, 36g, 43b, 91, 102b, 102c, 113b, are common enough to be of importance either for their wood or fruit; the others seem to be merely stragglers from the tropics. Besides these, 104, *Conocarpus erecta*, and 112, *Avicennia tomentosa*, are said to extend to Tampa Bay, lat. 28°, on the West side, and 21 other tropical trees or shrubs are described by Nuttall as being found on the Keys, (small islands,) which have not been found on the Main land. A list of these is given in the Catalogue before referred to, and they are described by Nuttall, in his continuation of Michaux's Sylva.

Of the preceding lists the following have been traced to various degrees South:

To St. Mary's river, lat. 30° 25′, the Northeastern boundary of Florida: 1e, 2, 3, 15a, 29, 30, 56, 57. To about lat. 27° 30′ in the interior : 17a, 25b, 32, 36c, 53t. To lat. 29°, at Lake George : 5, 6c, 12c, 38a, b, 53n, 55b. To lat. 28° 30′, on the St. John river, (Lake Monroe:) 10d, 11a, 13a, 19a, b, 27b, 37a, 40a, 45d, 53k. On the East coast: 1h, 21d, 26, 33a, 53e, q, 62i, 68a. To lat. 27° 30′: 8a, 52e, 53m, 61a. To lat. 25° 55: 49e, 44. To Cape Sable, the end of the State, in lat. 25° 15′: 1a, 4b, 9b, 34a, 53i, 1, 62h, 67, 71, 72. Of these all belong to the lowland Regions in greatest abundance, except the following: 2, 3, 15a, 30, 56, 57, 17a, 25b, 32, 53t, 5, 38a, b, 55b, 10d, 11a, 19a, 53c, 68a, 62e, 49a, 44: making 22 out of 54, and nearly all of these are mere stragglers from more Northern Regions, when their relative abundance, range, and growth is compared with that of the others mentioned.

THE CAMPESTRIAN PROVINCE.

This word *Campestrian* is here used to express the most marked characteristic of the "Prairie" and great "Central Plain" Regions of North America, which consists in their comparative destitution of forests and nearly uniform surface, gradually rising from the level of the Gulf of Mexico to the base of the Rocky Mountains, where they attain an elevation of from 4,000 to 5,000 feet.

Although with regard to the trees only the half-wooded prairies of the Eastern border might appear more properly connected with the Appalachian Province, their want of any *peculiar* trees, and the great change observed in their smaller vegetation and animals seems to point to their *want* of forests as a more important character than their partial existence Eastward.

The Eastern boundary of this Province has been already mentioned as forming the Western boundary of the Appalachian and the Southwestern limit of the Lacustrian Provinces. Commencing at the Rocky Mountains in lat. 60°, it runs Southeast to the South end of Lake Winipeg, lat. 50°; then sweeping round with a curve crosses Lake Michigan about lat. 43°, and terminates at the West end of Lake Erie, lat. 42°. There, turning abruptly at a right angle, it curves parallel to the Atlantic coast in a Southwest direction, and ends at the mouth of Sabine river, the Western boundary of Louisiana.

The valley of the Rio Grande forms the Southern boundary of this Province ; for crossing it into Mexico, mountains are found to come down almost to the coast, accompanied by a new and marked character of both animal and vegetable life ; a few of the forms straying across the boundary into Texas.

* *C. Floridana*, MEISNER, in D. C. Prod.; *parvifolia*, NUTT, not of Poiret.

The base of the Rocky Mountains, commencing with the Guadalupe Range of Western Texas, about long. 104° 30′, and running Northwest to lat. 60°, forms the Western boundary.

This Province may be conveniently divided into five Regions of about equal size and with distinct characters, viz: the Saskatchewan, (l,) embracing all North of lat. 49°, together with the basin of the Winipeg, or North Red river; the Illinois (k) or Eastern Region, bounded for the present by the forest Provinces on the East, the 97th meridian on the West, the 38th degree of latitude on the South, and the 46th on the North; these coinciding nearly with its natural boundaries; the Texan region (j) next Southward, and extending West to the 101° of longitude on the Rio Grande; while the remaining bare plains East of the Rocky Mountains are divided by lat. 38° into the *Dacotah* Region Northward and the *Comanche* Southward of it.

It is not necessary here to describe the geological and other changes which mark the line between the Eastern and Western Regions within the portion of this Province South of lat. 49°; the fact of there being an almost entire disappearance of trees even along the streams West of long. 97° at the North, and from that point to long. 101° South of lat. 38°, is sufficient for the present.

In the Illinois Region trees grow at first in groves scattered, or lining the river banks, and forming wider belts in proportion to the size of the river, thus becoming less extensive towards the Southwest and Northwest corners, which are the driest and least watered by streams. The Northeast corner, just South of Lake Michigan, being low and marshy, is also but thinly wooded.

The Texan Region differs in having many distinct trees and more extensive isolated groves not depending on the waters of the rivers, of which the most remarkable is the "Cross Timbers," a belt of forest extending almost unbroken from lat. 35° South to lat. 32°, near the 98th meridian, covering altogether about 6,000 square miles, and containing about forty species of trees of the Appalachian Province.

Connected with the existence of these groves is the uneven character of the surface caused by scattered ridges and spurs of the Ozark system of Mountains running Southwesterly through Texas.

Neither of these Regions having any peculiar trees or any which are most abundant in them, the following tables will show how they are distributed:

More abundant in Canadian Region	8
" " Ohio or Alleghany	43
" " Mississippi or Carolina	11
Total trees of Illinois Region	62

Others of Regions Eastward *not* found in it, 13.

More abundant in Appalachian Province	60
" " Mexican Province, (Southward)	12
Total of the Texan Region	72

The three remaining Regions being almost entirely woodless, have, of course, very few species of trees, but a few stragglers occur in them belonging to the Mountain Regions toward the West. None of these, however, are sufficiently abundant or luxuriant to be of much use except the following, unless it is along the extreme boundaries of the Regions:

Cda, 42a. *Fraxinus Americana*, White ash.
Cda, 45b. *Ulmus Americana*, White elm.
W? 61d. *Populus monilifera*, Western cottonwood.
All. 68a. *Juniperus Virginiana*, Red cedar; Juniper.

The remaining species are distributed as follows:

	Comanche.	Dacotah.	Saskat.
Trees more abundant Northward	1	2	3
" " " Southward	9	0	2
" " " Eastward	8	12	6
" " " Westward	4	2	?
Total found in each Region	22	16	11

RELATION OF TREES TO CLIMATE IN EASTERN NORTH AMERICA.

There can be no doubt that the Northern limit of forests on this Continent depends chiefly on the temperature, although observations having been made at only few and scattered localities along the line, it is not possible to say what isothermal lines correspond exactly with it. Besides, they will be found to vary along different portions according to the following circumstances :

It has been found that one chief condition for the growth of every plant is the total amount of heat to which it is exposed while growing, ascertained by adding together the mean temperature of all the days during which it is growing, from the time the seed sprouts until the plant dies. This has been proved very distinctly with regard to animals, and is doubtless not less so respecting perennials.* Thus not only the mean temperature of the year must be considered, but in these Northern Regions that of summer also, being the only season in which vegetation is active. Therefore, Regions with a lower annual temperature may, from having hotter summers, produce plants which would not grow in other Regions where the winter and the annual warmth are higher, but the summer heat lower. This is well known to be the case in comparing the productions of the Eastern United States with those of Europe in the same latitude, or with those of our States on the Pacific.

The second most important condition is the degree of cold to which the temperature sinks in winter; for, as is well known, certain trees may grow well for years in some localities, and then be killed by an unusually cold winter.

Judging from isothermal lines well established in more Southern latitudes, we cannot expect this Northernmost limit to be exactly parallel to the lines of temperature for any season throughout its length from the Atlantic to the Pacific ; for besides the irregularities depending on different elevations of the surface, would be those arising from the conditions just mentioned, which differ towards the East and West sides of the Continent.

Still further, the influence of climatological conditions being different on each distinct species of tree, it must be ascertained that some one species grows along the whole line ; and if, as is very probable, several do so, they may then be differently affected by the various relations of the summer and the winter lines to each other along various portions of the tree boundary. These circumstances will be further discussed hereafter.

The main points to be attended to regarding this Northern limit are, that it reaches its highest point near Behring's Straits and Makenzie's river ; its lowest at or near Hudson's bay, about long. 97° W. The first of these facts corresponds with the mildness of the winters towards the Pacific coast; the second with their severity near the 97th meridian, all the way South of the Gulf of Mexico.

Richardson and others speak of trees, varying in age, being found dead at points beyond the present limit of their Northern range, indicating, probably, an excessively cold winter at some late period, or a number of such winters occuring at intervals, or finally a gradual and progressive increase in their severity, which may be still going on.†

The next marked boundary towards the South, that separating the Canadian region from those Northward of it, has a course nearly parallel to the Northern limit of trees, those limited by it in their Northern range extending at least four degrees further North along the Lower Saskatchewan than at the Gulf of St. Lawrence, and probably six degrees more than at Lake Superior, which lies near the meridian of greatest cold. The elevation of the country, although reaching a thousand feet near the Western end of this region, does not seem to influence the vegetation much, the difference of temperature being only about three degrees at that elevation. The height of the ridge bounding the St. Lawrence basin on the North, though not distinctly known, may, to a slight degree, protect vegetation immediately South of it from the Arctic blasts which would destroy it to the North, and thus enters as an element of the boundary.

It is not *known* that any difference in climate, as regards moisture, prevails between the regions East and West of Hudson's bay ; but the Algonquin, on the East, being nearly surrounded by water, is probably more abundantly supplied with rains than the Athabascan. This induces the belief that the trees known to be limited to the Eastern part of the Canadian and Eastern slopes of the Alleghanies (58d, 58c, 58e, 58a, 61b of Canadian list) require more moisture than is found in the Athabascan region, and may, one or all, be most abundant in the Algonquin.

Richardson tells us that the winters are very dry at Great Slave lake, and that evaporation is rapid and complete in the coldest weather, the snow and even the ice disappearing in this way, while the cold remains for weeks together below zero. Still the ground seems to be everywhere covered with a deep snow through the cold months, and the amount of

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* A. De Candolle, translated in Smithsonian Rept., 1858, p. 237.

† Richardson, Arct. Searching Exped., App., 8vo., ed. (Harpers', N. Y.,) p. 416.

precipitation both of snow and rain is evidently so proportioned to evaporation, and falls so seasonably, that none of the effects of drought are apparent. Judging from the vast number of lakes and marshes covering so much of the surface, one would suppose that the climate was very rainy; but we must take into account the facts that from the low annual temperature less is evaporated than further South, while the impervious and often nearly bare rocks hold water, and drainage is imperfect from the flatness of the surface.

The importance of these conditions to the existence of the vast forests of this Province will more clearly appear when we consider the Campestrian province, whose Northeastern border forms the Southwestern boundary of this. Along that line the water-holding rocks become covered with strata of great thickness and porosity, which, probably, assisted by a less abundant precipitation in going Southwest from Hudson's bay, becomes unquestionably the cause of the sudden disappearance of trees, excepting along the rivers. This effect of drought will be more fully discussed in subsequent pages.

The extension of the Lacustrian forests Southward along the Appalachian Mountains is in conformity with the conditions of climate and geological structure above given.

Under the general law that mean temperature decreases about three degrees for each thousand feet elevation, many trees find a congenial climate throughout a very large portion of the upland Regions, as well as the Mountains, while others are limited to the higher peaks, and grow higher and higher upwards as they progress towards the South. Many interesting facts relating to this *vertical* distribution will, in time, be collected, as has been done in Europe, showing exactly the laws of climate by which it is governed; but as yet scarcely anything has been recorded in this country on the subject of these zones.

The other condition, that of moisture, shows its influence in the difference between the trees of the Alleghany and Ohio Regions. The Alleghany, having a soil underlaid in a great measure by impervious crystalline rocks, and receiving more moisture in the form of rain and fog from the Northeast storms of the Atlantic coast, several Lacustrian trees are much more common there than West of the mountains, such as 10a, 62j, 62c, 61b, while those marked All. in preceding lists probably owe their more abundant or peculiar occurrence to the same causes.

The influence of a milder annual temperature in this Region is also shown by the more Northerly extension of Southern trees along the Atlantic coast, as remarked in comparing their range here with that in the Mississippi valley.

In the Ohio Region, on the contrary, are found a soil less tenacious of moisture, less precipitation of rain, hotter summers, and colder winters. With these conditions are several trees reaching a more Northerly limit than they do East of the Alleghanies, especially 3a, 5, 11a, 17a, while many others, as before observed, do not extend across the mountains at all, or only as rare stragglers. A curious fact connected with this, though probably not *depending* on climate, is, that none of the evergreen Coniferae of the Canadian Region and none of those of the Alleghany Region are found except as stragglers in the Ohio Region, or in the Illinois Region, next west of it. The same is the case as to the *broad-leaved* evergreens of the Alleghany Region, 30, 31a, and 33a, of the Carolina Region, which extends North to Maine. But in place of the Ericaceae of the Alleghany the Ohio Region has the leguminose, or pod-bearing tree, growing much more to the North, than those numbered 18, 17a, 19a, which scarcely appear in the Alleghany Region except as stragglers, and South of latitude 41°, while they reach latitude 43° on the West side. But allowance must be made for other barriers to their Eastward range besides climate, since they grow as far North when cultivated on the Atlantic slope, but it is believed they do not usually ripen seed. The tree vegetation of the Ohio Region is, then, almost entirely deciduous, as is that of the Illinois and other Regions further West between the same parallel of latitude.

The Tennessee Region has more moisture and heat, both in summer and annually, than either of the preceding, and, as has been remarked, several trees are peculiar or characteristic of it. That these do not reach Southward towards the Gulf to any great extent is probably due more to a change of soil than of climate. Around its Southern border and along the front of the Ozark Range, facing the Gulf, the Alleghanian evergreens, 30, 31a, 62f, (?) 62e, 62b, extend their range, together with some other trees rare in the Ohio and Illinois Regions, but going pretty far North in the Alleghany, viz: 2, 10b, 25b, 52b, 52f, 53g, 54a, 68a. This fact is, without doubt, connected in a great degree with climate, as will appear in future pages.

It may often be observed that the range of certain trees does not well conform to the general division of the country into lowland and upland Regions. This is shown in the case of the rhododendron, which towards the North forsakes the high dry hill-sides, and grows only in cedar swamps, together with plants both of the Lacustrian and the lowland Regions. But in such cases the dense growth of cedar (*Cupressus thyoides*) causes a marked difference in climate from that surrounding the swamps, protecting the Lacustrian plants from the excessive heat of summer, and the lowland Carolinian plants from the severe cold of winter.

In the three lowland Regions similar differences may be found in the range of trees con-

nected with diversities in climate, while there is less difference in the character of the soils, especially as to their retention of moisture, swamps, though extensive, depending on imperfect drainage only, and occupying the lowest lands.

The Mississippi Region has hotter summers but colder winters than the Carolina, and it has already been shown that nine species extend from two to five degrees further North in the Carolina Region, and nine more one or two degrees. Its few most peculiar trees doubtless require the increased summer heat and moisture.

Its other *characteristic* forms are mostly those of swamps and overflowed lands, which are much more extensive than in the Carolina Region, but furnish only two or three of the peculiar trees, viz: 27c, 46, 47c, (variety?)

The Florida Region has a greater and more uniform temperature, combined, according to the records so far made, with irregular rains, sometimes excessive, at others deficient in amount, especially towards its extremity. With these characteristics of climate, we find many of the trees of the other lowland Regions disappearing towards the South, and scarcely any peculiar kinds occurring. The tropical forms which occur, plainly owe their existence chiefly to the warmer climate, though some of them grow only on the coral formation near the Southern end, and may require that calcareous soil in some degree. Extensive woodless Savannas, improperly called "prairies," are due to the influence of standing water during the wet season.

Considered as a whole, the Appalachian Province presents the following relations between climate and vegetation:

Its summers being of an almost tropical heat, it has several trees as well as smaller plants belonging to tropical families, and unrepresented by any analogous forms in Europe or Northern Asia, such as its Asimina, (3a,) Gordonias, (8a, b,) Nyssa, (27a, b, c,) Bumelias, (36a, b, c.) The following genera also, though belonging to families there represented in small numbers, seem here to be specially adapted to our tropical summers, forming (except 52 and 4) trees of much larger size than their nearest allies on that continent, viz: Kalmia, (30,) Sassafras, (44,) Carya, (52a, b, c, d, e, f, g, h,) Gymnocladus, (18,) Liriodendron, (2,) Robinia, (15a, b, c,) Oxydendrum, (32,) Chionanthus, (41,) Halesia, (38a, b,) Cladrastis, (16,) Persea, (43a, b,) Cyrilla, (29,) Cliftonia, (14.)

Several other families and genera are North of the tropics, represented by near allies only, on the West coast of Asia or its Southeastern corners, (47, 12, 26, 46, 9, 51,) in Regions having a climate very similar to ours, as Juglans, (51a, b,) Zanthoxylum, (4a, b,) Vitis, (9a, b, c, d,) Symplocos, (37,) Celtis, (47a, b, c,) Magnolias, (1a, b, c, d, e, f, g, h,) Negundo, (11a,) Maclura, (48,) Aesculus, (12a, b, c, d,) Gleditschia, (19a, b,) Liquidambar, (26,) Taxodium, (67,) Sapindus, (28,) Planera, (46,) Catalpa, (35,) Torreya, (70a.)* Very few trees of other genera take the place of our peculiar forms, and of these three of Europe and one of Asia are represented along our Western coast. Of Aesculus, Quercus, (53 of 17 species,) Populus, (61 of 6 or 8 species,) Pinus, (62 of 10 species,) and Abies, common to both Continents, we have a larger number of species, without counting these of our West coast.

This superiority, both in number of genera and of species, has an undoubted connexion with two chief characteristics of the climate of the Appalachian Province, viz: its hot summers, and, even more decidedly, its *abundant* and *seasonable moisture*. As shown by Professor Henry, in previous articles on Meteorology published in this Report, the rain-bearing winds come chiefly from the Gulf of Mexico towards the North, laden with moisture from that warm evaporating basin. As they proceed they are turned Eastward by the motion of the earth, and probably along their Western edge, by the counter current from the West. This coming dry and cool from the Rocky Mountains, condenses the moisture of the South wind, producing abundant rains, in fact excessive just North of the Gulf, but becoming less and less up to the forty-second degree of latitude. A great part being also carried Eastward, is deposited more plentifully near the Mountains and East of them than in the Illinois Region.

The coincidence between the Western limit of distribution of these rains and the Western limit of continuous forest will be at once apparent, and though the Illinois Region has at times even a superfluity of rain, it is undoubtedly at irregular intervals subject to severe droughts, which, as will be presently shown, cause the disappearance of several kinds of trees and the prevalence of woodless prairies over large surfaces.†

The influence of cold winters is shown by the absence of many trees in the Upper Mississippi valley, (North of latitude 38°,) which as already mentioned extend much further North near the Atlantic.

Though this severe cold cannot be considered in itself at all *favorable* to tree growth, yet the cause which produces it is very essentially so. This cause is the prevalent Northwest

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* Professor Gray's articles in Silliman's Journal of Science, vols. XVIII, 1857, and XXVIII, 1859, with other authorities.

† See Patent Office Agricultural Report for 1858, p. 477, &c.

wind of the Continent, which, while causing our severest winter cold, serves in summer to condense and precipitate the moisture of the wind coming from the South.

Allusion has before been made to the probability of some moisture coming from the Northeast over the Lacustrian Province, and also over those parts of the Appalachian East of the Alleghany Mountains.

Mountains under usual conditions receive more rain or snow in proportion to their height; and evaporation being also less rapid, trees of some kinds are thus favored on their higher parts to the exclusion of others which cannot bear the cold at that elevation. Thus the local Sylva of the higher Alleghanies and of the Tennessee Region may be understood; mountains also, by compelling the moist currents of air to rise and pass over them, deprive them of more or less moisture, condensed during their mixture with cold upper currents. In this way the higher ridges of the Alleghanies towards their Southern end intercept much rain which would otherwise pass Northward, and the interior mountain regions of Virginia and Pennsylvania, though often elevated, are locally drier than surrounding tracts. Probably this, in connexion with the action of extensive fires, is a cause of the thin forests, *glades*, and *barrens*, which occupy much of their surface. The Ozark Range also seems to intercept some from the Prairie country immediately West of it.

Though the intimate connexion between the climate and forest growth is thus rendered apparent, and will be still more so after the consideration of other Regions, it would be unphilosophical to suppose that climate is the *cause* of the great richness of our Sylva. It may be that the unnotable and badly defined forms which have been distinguished by the botanical term *variety*, (var.,) are one or all dependent for their variation from the specific type upon climate; but the well marked *species* were undoubtedly *created for* the climate in which they exist. Were it not so the East coast of Asia which most nearly resembles the Appalachian Province in climate, and produces many similar ferns unknown on the *West* coast of either Continent, might, as far as the climate is concerned, have produced *all* our peculiar forms or their analogues.

Yet with the resemblance there is much difference, each country having several trees peculiar to it, but which would doubtless, as in the case of the Ailanthus, the Pride of China, and smaller plants, be found perfectly capable of naturalization in the other, although nothing very like it had been produced there.

Thus the higher law of specific distinction, forming the foundation of organic classification, must be taken into account in comparing these countries, while such a comparison must still be of great service in the study of their climates.

If each of our trees was created originally within a narrow area, and has thence spread over so great an extent as some occupy, even such as are diffused slowly by seeds, (18, 19a, 51, 52, 53,) we may believe that the present conditions of climate have not materially changed since, at least, the commencement of the recent (geological) period.

Having assumed that the chief cause of the almost universal and dense forests of the two preceding Provinces was their full supply of moisture, especially during the vegetating seasons, it is now necessary to show that contrary conditions cause contrary effects. It has already been mentioned that the Western border of the continuous forests coincide closely with the line of direction of the rain-bearing winds from the Gulf, and North of latitude 43°, with the line between the impervious rocks and porous strata above them, as well as with the supposed influence of Northeasterly rains.

It is the common belief that the Prairies which commence at this line were once covered with forest, but became bare through the annual burning which, from time immemorial, has been prevalent, either from natural causes or begun by Indians. This was doubtless true in some degree, especially near their Eastern borders where, since fires have been prevented, young forests are rapidly spreading. But why then did not the fires frequently ignited South and East of the Alleghanies cause prairies there also? Doubtlessly because more abundant and frequent rains soon extinguish them, and promote so rapid and dense a growth of young trees that grasses are killed under their shade, and a fire can scarcely make any progress through their damp green thickets. In the Prairies, on the other hand, one or two dry seasons in succession will prevent the growth of seedling trees, and allow an accumulation of dry herbaceous plants, which need only a spark to cause a conflagration fatal to the young trees, but of little injury to the herbs.

The "glades" and "barrens" of the Western Alleghanies, before spoken of, were a kind of imperfect prairies, where, from peculiarities of soil, grasses did not exclusively occupy it, and fires, wanting a large supply of light fuel, did not destroy all the trees. The *barrens* also seem to have had a group of shrubby oaks and other woody plants especially formed for them, presenting a sort of compromise between prairie and forest. These, like the prairies, are becoming generally overgrown with large trees since fires were stopped.

On the Prairies trees of many kinds grow along the river banks and in wet grounds, being protected from the fires. But it has been mentioned that 13 trees found in the Ohio Region which borders the Illinois Region on the East side in the same latitude do not extend

into it, being checked at the very commencement of Prairies, (53g, 61c, 54a, 9a, 1b, 25b, 45c, 2, 3, 12d, 15, 26, 27a.) This may be in part owing to the greater cold in the same latitude near the Upper Mississippi, and to the violence with which the cold winds sweep across the unsheltered level Prairies, but only 3, 12d, 15, are known to cross the border of prairies into the Texan Region.

A wider belt of woods borders the larger rivers, not only in the bottom-lands but on the higher grounds, showing perhaps greater moisture locally. But all become scarcer as we go West, until on reaching the 97th meridian, North of latitude 38°, and a degree or two further West in Texas all but a few before mentioned have disappeared.

This is still the effect of dryness, increasing towards the West; and when we come to the line where more porous strata cover the carboniferous, the sudden termination of almost all kinds is very marked. In the Texan Region, however, it is less so, probably from irregular combination of the strata.

THE ROCKY MOUNTAIN PROVINCE.

At the Western border of the Campestrian Province, as before described, the general features of the country suddenly change from a uniform plain surface, to one of the greatest irregularity, consisting of lofty chains of mountains, alternating with valleys, basins and plateaux, which characteristics prevail throughout all the remainder of the continent not included in the three Provinces already described.

From the facts collected respecting distribution of plants and animals over these Western regions, it seems proper to divide them also into three, and perhaps four Natural Provinces nearly similar in area, and each containing several distinct Regions.

The first of these to be spoken of is that lying entirely within the United States, and forming the high central mountain system of the continent, from which rivers diverge in various directions, and run towards far distant outlets in both oceans.

This Province presents characters common to all those previously described, since it includes peaks covered with the perpetual snow of the Arctic zone; forests just below them composed of evergreen Coniferae like those of the Lacustrian Province; other forests still lower down, consisting of the oaks, maples, &c., of the Appalachian; and finally at various elevations, the rich Prairies of the Illinois Region, or the treeless plains and deserts of the Comanche Region. This combination is only found in the middle portions of the Mountain system, and between the elevations of 500 and 1,200 feet above the sea level.

Four distinct Regions are embraced in this Province, differing in their natural productions, but not yet sufficiently explored to have their characters or limits well defined. They may, however, be described as the four fountain heads of distinct River systems first alluded to, viz: the Padoucan Region, (t,) including the Eastern mountain slopes and most of the basin of the Yellowstone river; the Wasatch, (s,) including the Western slopes from which the Colorado and its branches rise, as well as the Wasatch range West of it, both of these extending South to about latitude 36° 30′; the third is the Utah Region, (u,) including the inland basin of that name, with the adjoining mountain slopes; and the fourth the basin of Snake or Shoshonee river, (v,) giving a name to the Region, with most of its collateral valleys, and the upper Columbia or Spokan plains, up to latitude 48°. But the mountains and valleys around Clark's Fork are nearly *continuously* wooded, and belong, with the Region West of the Cascade mountains, to the next Province towards the North.

Few trees are yet *known* as peculiar to or very characteristic of these Regions, but more doubtless remain to be discovered on the almost unexplored parts of the higher slopes, which are the only parts of these central mountains wooded.

Commencing with the Black Hills of the Yellowstone Region, besides 58a, 62a, 62f, 63d, 68b, of preceding lists, the following new trees are met with:

P. 62v. *Pinus Wislizeni,** Wislizenus pine.	P. 62r. *Pinus flexilis,* Flexible pine.

The latter being yet known only from Pike's Peak, latitude 38° 30′, the former extending South to Santa Fé.

On the headwaters of the Missouri, and perhaps further North, is found a tree common to all the river banks West of the great Plains, where it accompanies another usually considered identical with 61e of the Ohio Region. The first is—

? 61i. *Populus angustifolia,* Narrow-leaved poplar;	? 61d. *P. monilifera,* Western cottonwood,

being the other, and ranging East at least to the Mississippi, wherever trees grow on river banks.

* *P. flexilis*, Engelmann, (not of Torrey.)—Senate Doc. 26, 1848, page 89.

The following Eastern trees also grow at the foot if not on the slopes of the mountains: 9d, 11a, 21b, 42a, 45b, 53a, 61a, 68a, and the two last cross them in small numbers.

In the Wasatch Region, on or near Bear River mountains, have been found:

W. ? 10i. *Acer tripartitum*, Three-cleft maple.

? 60f. *Salix pentandra, (Eur?)* Bay-leaved willow.

The latter extending through the Shoshonee valley.

In the *Shoshonee* Region, near latitude 48°, occur—

U. 68c. *Juniperus occidentalis*, Utah cedar.

U. ? 49d. *Celtis reticulata*, Rough-leaved hackberry.

The latter at latitude 46°, and extending South to latitude 32°, where it crosses the mountains to the Comanche Region.

In the Utah Region, near latitude 42°, are met—

? 11b. *Negundo, var. ? Californicum*, California box elder.

W. ? 62k. *Pinus, var. ? monophyllus*, One-leaved nut pine;

both extending South to latitude 35° on the mountains. 61i, 61d, 68c, 62k, form the chief timber trees of this Province, though others of the Eastern group above referred to, and a few of the Western to be hereafter mentioned, occur locally on several ranges of mountains, or along river banks, where, however, 61d and i, 60f, and other willows, are almost the only woody plants.

In these elevated plains there is a group of shrubs, from four to ten feet high, which hold the place of forests, and supply all the fuel or woody material to be found for hundreds of miles. Of these the "wild sage," *(Artemisia tridentata,)* "greasewood," *(Purshia tridentata,)* so called from its combustibility, various species of *Linosyris*, and the "pulpy-leaved thorn" of Lewis and Clarke, *(Sarcobatus vermicularis,)* form the principal growth. They are nearly all useless as fodder, or indeed for any purpose except for fuel; but it is said that the camel is very fond of the greasewood, a plant entirely different from any other found in the Appalachian Province, and probably in any other.

This will make these Regions traversable much as the deserts of the Old World are, to which they otherwise show much analogy.

These shrubs, growing almost universally over the plains which are elevated more than four thousand feet, and between the main ranges which border these table-lands *West* of the Rocky Mountains, form an important character, distinguishing them from the lower Plains of the Campestrian Province.

THE CAURINE PROVINCE.

The nearly treeless Mountain Regions being thus disposed of, starting again at the Northern limit of forests, West of the Lacustrian Province, a varied and nearly universal forest prevails, giving character to what may be called the Caurine Province (Northwest.)

At Behring's Straits trees reach about as far North as at Mackenzie's river, *i. e.*, to latitude 67° 30′ at the sea-level, but probably less far in the mountainous interior.

As might be expected from the fact that no treeless plains separate the two Northern Provinces, and that the mountains are so low as to admit the passage of several rivers running from their West side into Mackenzie's river, several trees of each Province cross into the other, and specimens of some Western forms by Richardson along the Mackenzie give us their Northeastern range. Of these two reach the mouth of Mackenzie's river, viz:

60k. *Salix speciosa*, Showy willow.

60h. *S. longifolia, var ?* Long-leaved willow.

At Slave lake, lat. 60°, he found—

O. 21e. *Cerasus mollis*, Oregon cherry.

? 23m. *Crataegus sanguinea*,* (Asia,) Siberian hawthorn.

21b, 22c, 24a, 58b, 62a, of the Lacustrian Province probably cross the mountains to the West side near here, as they are found South to lat. 46° on the mountains.

At lat. 58° he found "*Rhamnus alnifolius*," probably O. 13b. *Frangula Purshiana*, Oregon buckthorn.

* S. glandulosa of Richardson.

On the Rocky Mountains, at the head of the Saskatchewan, Drummond found (at lat. 53°):—

58g. *Betula Occidentalis*, Northwestern birch.
? 62t. *Pinus monticola*, Rocky Mountain white pine.
O. 65b. *Thuja gigantea*, Oregon white cedar.

Lower down the river, at Cumberland House—

? 58f. *Betula glandulosa*, Bitter birch.
? 66b. *Cupressus Nutkatensis*,* Nootka cypress.

On the Mountains, at lat. 50, Nuttall (?) found—

Y. ? 10h. *Acer glabrum*, Smooth-leaved maple.
10j. *A. grandidentatum*, Notch-leaved maple.

Going now to the Pacific coast at Behring's Straits, we find the circumpolar species (belonging also to the Old Continent,) 59a, 59b, 68b, with 61a, 63e of the Lacustrian Sylva, and 60k, these also extending along the mountains to or near lat. 49°. One new spruce also occurs, if not the same as 63e, which it resembles; viz: 63q, *Abies Sitchensis*, Sitcha spruce.

At Sitcha, lat. 57°, another is found resembling 63a, if not identical, (that being also reported to be found there,) viz: 63p. *Abies Mertensiana*, Mertens' spruce, together with 61i (?), 65b, and 66b, just mentioned. Also:

O. 10f. *Acer macrophyllum*, Broad-leaved maple.
O. 10g. *A. circinatum*, Round-leaved maple.
O. 22d. *Pyrus rivularus*, Oregon crab-apple.
O. 25d. *Cornus Nuttalli*, Oregon dogwood (?).
O. 59c. *Alnus Oregona*, Oregon alder.
O? 63f. *Abies Menziesii*, Western black spruce.
O? 63o. *A. Canadensis? var.*, Western hemlock spruce.
(O? 66b. *Cupressus Nutkatensis*, Nootka cypress.)

Thus we know of 20 new forms of trees, with 10 or 12 Eastern kinds, growing in this far Northwestern Province, North of lat. 49°, and others will doubtless be added, showing a very rich forest growth.

At Nootka Sound, lat. 50°, Vancouver's Island, are:

O. 53c.† *Quercus Garryana*, Oregon white oak.
O. 63n. *Abies Douglassii*, Red or Black fir.

with 13b, and 65a? ‡

At lat. 48°, Straits of Fuca, are found:

O. 31b. *Rhododendron maximum?* Variety? Northwest R.
Cal. 83. *Arbutus Menziesii*, Madrona laurel.
(? 58g. *Betula Occidentalis*, Northwestern birch.)
O. 42h. *Fraxinus Oregona*, Oregon ash.
O. 62m. *Pinus contorta*, Scrub or Twisted pine.
O. 69. *Taxus brevifolia*, Oregon yew.

But it is most probable that none of these lists indicate the extreme limits of the species toward the North, the botany of British Columbia having been as yet almost untouched. In the interior, between the Cascade and Rocky mountains, two very fine trees are added, North of lat. 50°:

? 62p. *Pinus ponderosa*, Heavy yellow pine.
? 64b. *Larix Occidentalis*, Northwestern larch.

About lat. 47° seem to be the Northern limits of—

Cal. 21g. *Cerasa demissa*, Shrubby cherry.
? 23u. *Crataegus rivularis*, Oregon hawthorn.
Cal. 5e. *Cornus pubescens*, California green dogwood.
O? 60i. *Salix brachystachys*, Coast willow.
O. 60g. *S. Hookeriana*, Oregon willow.
O. 63g. *Abies grandis*, Yellow fir.

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* "*C. Thyoides*" Richardson, but this being confined to the East side of the Alleghanies and South of the St. Lawrence, the species found was more probably the above, being a straggler across the mountains, and, as Richardson says, seen only in one spot.

† The West coast oaks are all distinct from Eastern, and the alphabet commences again with them.

‡ "*Thuja plicata*" Lambert (not of Nees) in cultivation proving to be *T. Occidentalis* according to Loudon.

Between lat. 46° and 42° in Oregon:

C. 84a. *Arctostaphylos glauca*, Smooth manzanita.
C. 84b. *A. omentosa*, Downy manzanita.
C. 54e. *Castanea chrysophylla*, Evergreen chestnut.
O. 63b. *Abies lasiocarpea*, Downy-cone spruce.
O. 63h. *Abies nobilis*, Cascade mountain spruce.
O.? 63k. *A. amabilis*, Oregon silver fir.

Of the above more than half cease to appear at or near lat. 42°, or continue Southward only along the Mountains, gradually becoming higher in their range until they disappear. 53c (?), 83, 42h, 21g, 60i, 84a, 84b, 54e, extend through the valleys of California, and 83 even into Coahuila, Mex., on the mountains South of Texas.

But at least 35 of these new trees are fully characteristic of the Caurine Province, to which the forest Region West of the Cascade mountains must be considered as belonging, forming part of the Oregonian Region (x) which seems to extend with its trees up to Sitka along the coast.

East of the Cascade range most of the peculiar trees of this Region disappear South of lat. 49°, and are replaced by 10h, 23m, 62p, 62t, 64b, 68c, and others which are unknown West of that range except as stragglers. These are characteristic of a second Region, the Kootanie, (y,) extending from about lat. 43° in the Rocky Mountains, down the densely wooded valley of Clark's Fork to the Great Columbian Plain, lat. 48°, whence it passes North into British Columbia, and probably includes the upper valley of Frazer's river, with perhaps a corresponding one Northeast of Sitka.

Finally, the most Northern river basins up to the limit of forests, being separated from the last by high mountains, from which some streams flow East into Mackenzie's river, seem to form another Region, termed from its chief river, the *Yukon*, *(z.)* Its trees being, however, almost unknown, we cannot say which are most characteristic of it.

THE NEVADIAN PROVINCE.

Californian Region, (w.)—Between lat. 43° and 42°, in Southern Oregon, commences a new group of trees, characteristic of a new Province, called the Nevadian from its most remarkable range of mountains.

About the high snowy peaks and on the slopes are found the following:

Cal. 62n. *Pinus Sabiniana*, California nut pine.
Cal. 62q. *P. insignis*, Western pitch pine.
Cal? 62s. *P. blauana*, *(?)* Newberry's nut pine.
Cal. 62u. *P. Lambertiana*, Sugar pine.
? 63j. *Abies Williamsoni*, Williamson's spruce.
Cal? 63m. *A. bracteata*, Leafy-cone spruce.

Lower down, and in the valleys, a group of *deciduous* trees begins to appear, and towards lat. 41° several broad-leaved evergreens viz: 82, 53e, 53i.

Cal. 9e. *Vitis Californica*, Californian grape.
Cal. 11b. *Negundo Californicum*, California box elder.
Cal. 12e. *Aesculus Californica*, California buckeye.
Cal. 13c. *Frangula California*, Californian buckthorn.
Cal. 20c. *Prunus subcordata*, Californian plum.
Cal. 17b. *Cercis Occidentalis*, Western redbud.
Cal. 82. *Oreodaphne Californica*, Californian mountain bay.
Cal.? 50b. *Platanus racemosa*, Mexican sycamore.
Cal. 53e. *Quercus chrysolepsis*, Thick-cup live-oak.
Cal. 53i. *Q. agrifolia.* Holly-leaved live-oak.
Cal. 53b. *Q. Californica*, Californian red oak.

At the level of the sea on the coast border are:

Cal. 66d. *Cupressus Lawsoniana*, Port Oxford cedar.
Cal. 86a. *Sequoia sempervirens*, Redwood.

On the mountains between lat. 41° and 39° appear:

Cal. 70b. *Torreya Californica*, Nutmeg torreya.
Cal. 86b. *Sequoia gigantea*, Giant redwood.
Cal. 85 *Libocedrus decurrens*, Californian "cedar."

And in the valleys:

Cal. 25c. *Cornus sessilis*, Californian dogwood.
Cal. 80. *Ceanothus thyrsiflorus*, Lilac-flowered ceanothus.
Cal. 53a. *Quercus Douglassii*, California white oak.
Cal. 53d. *Q. densiflora*, Evergreen chestnut oak.
Cal. 53h. *Q. Hindsii*, Long acorn live-oak.
Cal. 60j. *Salix lasiolepsis*, Woolly-scaled willow.

Thence South to about lat. 36° on the mountains:

Cal. 62o. *Pinus Coulteri*, Coulter's nut pine.
62n. *P. muricata*, Spiny-shell pine.
Cal. 66b. *Cupressus macrocarpa*, Large cone cypress.
Ariz. 68d. *Juniperus pachyphloea*, Thick-bark juniper.

And in the valleys:

Cal. 21e. *Cerasus ilicifolia*, Holly-leaved cherry laurel.
Cal.? 74. *Photinia arbutifolia*, ? ?
Cal.? 53g. *Quercus lobata*, Lobate-leaved live oak.
Ariz. 131. *Yucca baccata*, Fruit-bearing yveca.

Here we have 35 more trees making their appearance, and several, as far as known, limited to the Californian region, considering this, for the present, as embracing only that part of the State North of lat. 35°, and chiefly the valleys East of the Coast range. But here a number of new forms appear on the Western slopes of that range. Of the above some extend South into Lower California, and some of them Eastward. The former are 74, 80, 21e, 21g, 25c, 84b, 82, 53d, i, k, and l, 59c, (?) 62n, s, and u, 63n, 65b, 85, 66e, 86a, showing that the peninsula has enough *Nevadian* forms to be included in that province as a distinct region, which may be named, from its principal Indian tribe, UCHITAN! Only 9e, 11b, 13c, 83, 50b, 63g, 63h, 63n, 68d, range East of the Sierra Nevada to or nearly to the Mexican boundary, and some probably further on the mountains.

Between latitude 35° and 32° *West* of the Coast mountains appear:

Ariz.? 51c. *Juglans rupestris*, Mexican walnut.
Uch. 73. *Lithraea laurina*, Laurel sumach.
Uch. 53m. *Quercus acutidens*, Sharp-toothed live-oak.
Uch.? 59d. *Alnus oblongifolia*, Oblong-leaved alder.
Uch. 61j. *Populus trichocarpa*, Hairy-pod poplar.
Mex. 65g. *Thuja plicata*, Mexican arbor vitæ.
? 66f. *Cupressus var.? Gowana*, Gowan's cypress.

And at the boundary of the Peninsula, latitude 32°:

Mex. 119. *Pistacia Mexicana*, Mexican pistachia tree.
Uch.? 123. *Adenostoma spassiflora*, ? ?
Uch. 125. *Styphonia integrifolia*, ? ?
Uch. 62y. *Pinus Torreyana*, Torrey's pine.

All of these may be supposed to occur in the Peninsula, and only 51c, 59d, 65g, 119 are known to extend their range on the main land East of the Coast mountains.

THE MEXICAN PROVINCE.

So few, comparatively, of the trees in the preceding lists extend into the interior East of the Coast mountains, and so many new forms occur there, known more or less as Mexican, that it seems best to consider New Mexico, South of latitude 35°, as forming a distinct region by the name of Arizonian (r), and to attach it to the Mexican Province.

Very little is known of the trees of Mexico, or of their distribution, between latitude 32° and 20°, but along the boundary there is found to be less of a distinctive limit formed by the middle range of mountains than towards the North, partly from the fact that this range is low, broken, and scarcely forms a dividing water-shed between the waters running East and West. But further South there can be little doubt but that the productions of the opposite slopes of Mexico are distinct enough to form of them two Provinces.

The object is now to speak only of the trees found within the United States, and not to attempt to define their Regions of greatest abundance, except where they are believed to be the *Arizonian*.

This Region has a great variety of climate and soil, from the low dry sand plains of tropical temperature to lofty mountains of temperate climate, and successive level plateaus, from 1,000 to 5,000 feet above the sea. These, of course, produce a variety of trees suited to their various circumstances. On the higher lands and mountains are chiefly found those of the preceding lists which extend East of the Californian mountains, and also on the Eastern slopes of the Coast mountains, near latitude 35°.

Ariz.? 76. *Algarobia glandulosa*,
Honey-pod mesquite.
Ariz. 77. *Strombocarpa pubescens*,
Screw-pod mesquite.
? 98c. *Acacia Greggii*,
Gregg's acacia.
Ariz. 53k. *Quercus oblongifolia*,
Oblong-leaved live-oak.

62l. *Pinus edulis*,
New Mexican nut pine.
68e. *Juniperus tetragona*,
Square-leaved juniper.
133. *Brahea dulcis*, (?)
California palm.

Further East, on the higher lands, latitude 35°:

6f. *Rhus microphylla*,
Small-leaved sumach.
Ariz. 79a. *Berberis Fremontii*,
Arizonian barberry.
Ariz. 53b. *Quercus Gambellii*,
Arizonian white oak.
53j. *Quercus Emoryii*,
Arizonian live-oak.

53n. *Quercus confertifolia*,
Dense-leaved live-oak.

On river banks;

42g. *Fraxinus pistaciaefolia*,
Arizonian ash.

And in the low sandy torrid deserts:

126a. *Cereus giganteus*,
Saguaro cactus.

128a. *Opuntia arborescens*,
Free prickly pear.

The following have been, as yet, found only near the Mexican boundary:

124. *Dalea spinosa*,
Spiny dalea.
36f. *Bumelia reclinata ?*
Spreading bumelia.

129. *Chilopsis linearis*,
? ?
126b. *Cereus Thurberi*,
Pitahaya.

Extending from the Colorado East to Upper Rio Grande:

78. *Cercidium floridum*,
Green acacia.
121 *Olneya tesota*,
Palo de hiero.

122a. *Parkinsonia microphylla*,
Small-leaved palo verde.

Reaching Eastward only to the Central water-shed.

118. *Larrea Mexicana*,
Hediondo.
120. *Schinus molle*,
Peruvian (?) pepper tree.

122b. *Parkinsonia aculeata*,
Prickly palo verde.

Extending entirely across to the Gulf of Mexico.

One extends from San Pedro river (a branch of the Gila) East to the Gulf of Mexico, viz:

34b. *Diospyros Texana*, Japote persimmon.

From the middle range of mountains another group extends Eastward to the Rio Grande:

129b. *Echinocactus Wislizeni*,
Wislizeni's cactus.

62x. *Pinus Chihuahuana*,
Chihuahuan pine.

And 15c. *Robinia Neo-Mexicana*, Mexican locust tree, appears to attain its most Northern limit.

Of these, and preceding lists 6f, 9f, 11b, 13e, 17b, 34b, 79a, 98c, extend, in small numbers, into Texas, while 76 is there very abundant as far North as Red river, and East to the Gulf of Mexico.

In the Arizonian region 76, 77, 53b&j, 126a, 128a, are the most abundant and characteristic.

Along the lower Rio Grande the following trees of the Eastern slope of the Mexican Province are found completing the Catalogue for the United States:

98b. *Acacia Farnesiana*,
Guisache.
110c. *Cordia Boissieri*,
Nacavitas.

130. *Ehretia elliptica*,
? ?
60d. *Salix Wrightii*,
Wright's willow.

The successive tables with which the Eastern slope of Mexico rises from the Gulf to the Centre have each peculiarities of vegetation, &c., sufficient to indicate a division into the Natural Regions, which may be named, from their division into States, the *Tamaulipan*, (o) *Coahuilan*, (p) *Chihuahuan*, (q). Many of these trees of the Southern border scarcely rise above the growth of shrubs within our limits, and they are accompanied by a larger number of tree shrubs, which, covering large tracts with a kind of miniature forest, replace trees to some extent, as is the case in the Rocky Mountains province, with the shrubs before mentioned.

RELATIONS OF TREES TO CLIMATE IN WESTERN NORTH AMERICA.

Commencing again with the Northern limit of forests from Mackenzie's river West to Behring's Straits, it has been stated that several species extend entirely across, and a few even *around the pole* on both continents. Still there are enough distinct species of trees already known from Behring's Straits, or near them, to indicate that Nature has taken advantage of new circumstances, and adapted new forms to them, as is the case everywhere else.

These new circumstances are: First, the mountainous character of the Yukon Region, with its consequent variety of soils, and exposures to the influence of heat and moisture. Second, the greater uniformity and mildness of the climate, arising from the fact that as we approach the Pacific the West wind of the continent becomes the prevalent, and almost the only one, while, at the same time, coming fresh from the ocean, it is nearly of the temperature of the water and charged with moisture.

These conditions react on each other, the mountains intercepting the moisture of the sea-breeze, and permitting it to pass dried and cooled over their lofty snow-capped summits to the Regions East of them. Thus, in proportion to their height, unbroken extent, and transverse position in respect to the direction of the winds, will be their effect in modifying the climate of Regions to the East. Reasons have been given for believing that in the Yukon Region they do not act so completely as a barrier to the flow of rivers, or to the spread of trees Eastward, as they do further South, and this belief is supported by the known conditions of climate prevailing near their Eastern base.

The influence of the West winds upon the mountain ranges is to cause their Western slopes to have more moisture than their Eastern, just in proportion to the degree in which their altitude and extent serve to intercept this moisture. Other conditions of climate belong to particular Regions, such as the effect of the sun's direct rays upon Regions subject to its influence during the long and cloudless dry season, of radiation of heat under similar circumstances, of the local influence of snowy ranges of mountains upon the surrounding valleys, and of local evaporations. All these, if known accurately, would be found to cause further important differences in the physical conditions of the various regions, but for the present it must suffice to consider only the reciprocal influence of the Western sea-breeze and the mountain ranges as causing all the differences in distribution of forests and trees observed in these Western Regions. As almost nothing is known of the interior of the Caurine Province North of latitude 49°, we cannot say whether the supply of moisture is sufficient throughout to cause as universal a covering of forest as in the Lacustrian and Appalachian Provinces. As far as known, however, this is the case, with the exception of some comparatively small tracts of prairie in the valleys between the coast and Cascade Ranges, and in that of Clark's Fork of the Columbia. The writer has studied and reported on the origin of the former in the Supplement to vol. I, Pacific Railroad Reports, published in 1859.*

On the Mackenzie's river, latitude 60°, very near the low mountains, broken through by Liards (Poplar) river, Richardson found a *Crataegus*, and at latitude 58° a *Frangula*, genera of trees which do not appear in the Canadian Region north of latitude 50°. Again, on the elevated Rocky Mountains, in latitude 53°, Drummond found two species of *Acer*, a genus also limited by latitude 50°, in the Canadian Region. Two others reach latitude 57°, at Sitka, together with many plants not represented along the Atlantic coast North of latitude 43°; therefore the valleys of the Yukon Region may be found to possess a Sylva nearly as rich as that of the Canadian Region, though chiefly composed of distinct trees.

The next Region Southward, the Kootamie, is known only near its Southern end, at the Upper Columbia, in which locality the occurrence of many distinct trees, as well as some from the Lacustrian Province, have been noticed.

The Oregon Region, commencing at Sitka, latitude 57°, and extending West of the Cascade Mountains to about latitude 42°, has been shown to have its large and peculiar group of trees, which completely cover the surface from the level of the sea up to the Regions of perpetual snow, excepting the small extent of prairie in the valley before mentioned. It is also, as far as known, the most rainy, having a precipitation of from 55 to 90 inches annually,

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* Besides the small edition of 1,500, published by government, another edition of the Scientific portion is published by Bailliere, New York City.

being 15 to 37 inches more than the Mississippi Region, and with little difference in its distribution as to the seasons, excepting in the Southern valleys, where there is an imperfect dry season in summer.*

The maximum of rains on the West coast seems to be at Sitka, whence they decrease in amount Eastward and Southward. As the mountains form abrupt limiting barriers to these rains, they must usually act also as the boundaries to the Natural Regions, and these, therefore, have their longer diameter parallel to the coast, exactly contrary to its direction in most of the Tree Regions East of the mountains.

From the uniform temperature of the ocean from which the West wind comes, it differs much less with latitude than the winds of the Eastern side of the Continent, and we find trees, therefore, extending further North and South, while their range East and West is usually very narrow.

It has been seen that about lat. 60° the Rocky Mountains become so much more lofty and continuous as to separate almost completely the waters flowing towards the East and West, but one river—the Unjigah or Peace river—passing through their Eastern range at lat. 56 30°' to reach the Athabasca. Near the same point, as Richardson tells us, is the Northern termination of the Great Plains, forming our Campestrian Province. Southward of lat 60°, then, it is probable that the mountains have become so extensive and high as to cut off most of the rain carried Eastward by the Pacific winds. As the mountain regions grow wider and more elevated toward the South, the Great Plains become wider and drier—a fact which, no doubt, is mainly caused by the intercepting effect of the mountains West of them, connected with the fact that they receive little or no rain from other directions.

Again, at lat. 48°, near the Pacific coast, the Cascade Range, becoming almost unbroken, its ridge nearly throughout rising above the limit of perpetual snow, it cuts off almost all the abundant rains of its Western slopes from the "Great Plain of the Columbia" East of it; and exactly in accordance with the principle above alluded to there is an almost total disappearance of trees from that Plain, while they still grow on the mountains East of it, which, being higher than the Cascade Range, receive a supply of moisture from the air which has crossed the dry hot plains, to be condensed by the cooler strata chiefly toward the summits of these mountains.

Here, in going Southward, another principle of meteorology is involved in the discussion. As the temperature increases with nearness to the Equator, the air becomes capable of retaining more moisture uncondensed, or as vapor, and the wind in summer coming from a direction North of West towards a land radiating much heat from its surface, the moisture of the air is not precipitated unless it reaches a very great elevation on the mountains, and much of it passes over even the lofty Sierra Nevada, and, traversing the Utah Region, is finally condensed on the highest portion of the Rocky Mountains near lat. 41°.

But in winter, the sea-breeze coming from a part of the ocean *Southwest* of the Californian coast, and having become fully charged with moisture, the land having at that season a temperature lower than the sea, condensation takes place, and the winter rains of California are produced. More Northward we gradually approach the point, where, as at Sitka, the climate of the land is *always* cooler than of the sea, and rains continual.

According to the general principles of the precipitation of moisture, we find the Caurine Province universally wooded, with few exceptions, as far as known, and these consequent on local influences accordant with the same general principles. The Rocky Mountain Province is almost woodless, though many trees and even large forests exist about its higher mountain summits.

The Nevadian Province has peculiar characters connected with its alternate wet and dry seasons, with a high and uniform temperature. Omitting the Oregon trees, which extend only along its higher mountains, it has 54 species of trees—the same number as is found in the Carolina Region, similarly situated on the Atlantic coast. But the variety of conditions for their growth is much greater in the Nevadian Province, which has so many different circumstances of climate depending on elevation and exposure. In these respects it would compare most nearly with three the *upland* Regions of the Appalachian Province; but they have at least 30 more species of trees. As remarked when speaking of that Province, its great summer heat and constant rains are connected with its rich variety of forest trees. In California we have the heat; but the rains occur chiefly at the season when trees do not vegetate, and they are proportionally few in the number of species. They become also fewer in individuals from North to South, the proportion of land occupied by forest decreasing from 80 per cent. to almost nothing. Several species, probably checked by cold in one direction, and by drought in the other, have a very limited range on the mountains, especially 62n, 62y, 63j, 63l, 66e, 86b, 70, which have each but one known locality.

A similar narrow range of three trees of the Tennessee Region, and one of the most Southern Alleghanies, has been noticed.

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* U. S. A. Met. Reg. and Bengard, (quoted by Richardson, Expedition in search of Franklin.)

South of the 35th parallel the Coast Mountains are too low to cause the precipitation of much moisture, and the lower lands become generally too dry for trees, except a few species, which seem adapted to this dry climate, (74, 73, 123, 125.) Still, the higher mountains have a variety of trees of the Northern forms, with a few new ones, and evidently cut off considerable moisture from the lower Colorado valley immediately East of them, where no trees and scarcely any other vegetation grows, except close to the water.

The *Arizonian* Region, therefore, is excessively dry in its lowest portions; but receiving more and more moisture as we ascend, possesses, as has been shown, a large number of new forms of trees; many of them, it is true, mere stragglers from Mexico, or confined to very narrow limits. Its proportion of woodland is probably equal to that of California South of lat. 38°; but many parts of it are entirely woodless. The cactuses form a new feature in the woody growth, though scarcely trees, except in height, and in supplying, to a small extent, the place of others. They occupy the lowest dry plateaux, next above the river banks, which are lined by a few species of trees. On the higher plateaux come the mesquite trees and oaks, while other oaks, pines, walnut, &c., occupy the mountains.

The causes which prevent the Rocky Mountain Province from receiving a due share of rain from the West winds have been perhaps sufficiently indicated. But, judging from the fact that trees grow chiefly on their *Eastern* slopes, the mountains South of lat. 35° and East of the Rio Grande may receive a small supply of rain from the Gulf of Mexico. From lat. 35° to lat. 42° the Eastern slopes are almost woodless, or less wooded than the Western, but from there Northward become more and more wooded, in correspondence with the width of the plains East of them at these various degrees of latitude.

The subdivision of the Western regions into *zones*, of different elevation and vegetation, is yet impracticable. When discussing the resemblance between the Appalachian forests and those of the East coast of Asia, allusion was made to the affinity which also exists between the trees of California and Western Europe. A similar affinity exists between those of Europe and all our mountain Provinces of Western North America, though the latter has apparently the largest variety. Its arbutus, (83,) oreodaphne, (82,) pistacia, (119,) are represented also in Europe and Northern Asia, while its evergreen oaks have more congeners there than in Eastern America. Only 85, 86, and 80 of the California region are unrepresented there generically.

It may here be observed that the only apparent connexion between broad-leaved evergreens (excluding all Coniferæ) and climate is this, namely, that they always bear the greatest proportion to deciduous trees in those countries where the extremes of temperature are the least. Thus, in Florida, they are 64 in 102, or $\frac{63}{100}$; in New Mexico, 17 in 37, or $\frac{46}{100}$; in the Nevadian Province, 27 in 48, or $\frac{56}{100}$; in the Oregon Region, 5 in 20, or $\frac{25}{100}$; in the Alleghany Region, 3 in 90, or $\frac{3}{100}$; *none* in the Ohio Region or Northward, and but 16 in 160, or $\frac{10}{100}$, North of Florida.

CAPACITY OF THE VARIOUS REGIONS FOR CULTIVATION.

In the preceding pages this Continent has been divided into large and smaller sections, chiefly from the distribution of its trees; and to a great extent also the distribution of smaller plants and animals, as well as the barriers by which their range is limited, have been considered. In a state of nature trees, either singly or in forests, have great influence in this respect, since they furnish habitations, shelter, food, or shade at least, *indispensable* to a very large proportion of beings.

On the other hand, another equally large proportion cannot or will not live under this shade, or in the climates moist enough to produce trees. Thus we may divide the natural products of this Continent into two great groups, those living in the Forests and those of the Plains.*

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* As an instance showing the great influence of forests in this way, the following account is quoted from Darwin's "Origin of Species," American edition, page 69:

"In Staffordshire, on the estate of a relation, where I had ample means of investigation, there was a large and extremely barren heath, which had never been touched by the hand of man, but several hundred acres of exactly the same nature had been enclosed twenty-five years previously, and planted with Scotch fir. The change in the native vegetation of the planted part of the heath was most remarkable—more than is generally seen in passing from one quite different soil to another; not only the proportional numbers of the heath plants were wholly changed, but *twelve species of plants* (not counting grasses and sedges) flourished in the plantations, which could not be found on the heath. The effect on the insects must have been still greater, for six insectivorous birds were very common in the plantations which were not seen on the heath, and the heath was frequented by two or three distinct insectivorous birds. Here we see how potent has been the effect of the introduction of a single [species of] tree, nothing whatever else having been done, with the exception that the land had been enclosed, so that cattle could not enter. But how important an element *enclosure is* I plainly saw near Farnham, in Surrey. Here there are extensive heaths, with a few clumps of old Scotch firs on the distant hill tops; within the last ten years large spaces have been enclosed, and self-sown firs are now springing up in multitudes, so close together that all cannot live. When I ascertained that these young trees had not been sown or planted, I was so much surprised at their numbers that I went to several points of view whence I could examine hundreds

Forests, and secondarily trees, thus stand as representatives of great collections of created beings, whose existence depends more or less upon their presence; therefore the distribution of all must essentially coincide.

But civilized man enters the field, and the face of Nature is changed by his interference with the administration of her laws. He clears off the Appalachian forests, and substitutes for them and for their plants a new series—one which has followed him from the Plains of Western Asia, and is now meeting a corresponding group of plants (many nearly or quite identical) on the plains of Western America. Nine-tenths of the weeds that infest our cultivated grounds have thus been imported from the Old Continent, the remainder being natives, but formerly limited to open spots, too wet, dry, or barren for trees to grow up and kill the weeds by shading them.* At the same time nearly all the forest plants are being exterminated.

Man also submits cultivated plants to circumstances before unknown, and cultivation becomes a second nature to them. They flourish where, left to themselves, they would be soon crowded out by native vegetation, and under the influence of new conditions they vary from the original type of their species. Man selects successively the varieties best suited to his wants, and, in time, these become so changed that one would scarcely suspect their origin to have been from wild forms comparatively useless to us.

But, unless transported to some country whose climate is to some extent similar to that of their native land, they do not grow *spontaneously* from seed, or, in other words, do not become naturalized. It is the facility with which they do adapt themselves to all circumstances that makes those useless plants called *weeds* so abundant and troublesome, but each of them, like all other plants, varies in this particular.

We cannot, then, say positively that *any* plant is *uncultivable* anywhere until it has been tried, but we safely affirm that where it finds conditions most like those of its original land it will most probably attain the highest perfection.

Let us see, on this assumption, how far our cultivated plants have already shown a superiority in regions like those they came from, and also what other regions are likely, for the same reasons, to prove best suited for them.

In the following lists those which show *very marked* preferences in this way are distinguished by capital letters. In some cases the original country is uncertain, but probably nearly correct; the resemblance of climate is merely known approximately:

COTTON, Kidney and Lima (Lunar?) beans, INDIGO, Hemp, Watermelons, SUGAR-CANE, FIGS, Okra, and Pumpkins, were from Southeastern Asia, and find the most analogous climate in our Mississippi, Carolina, and Florida regions; but the annuals among them are cultivable much further North, on account of our hot summers. Their range of naturalization differs also, as it doubtless did in their native regions.

Tea, RICE, Broom-corn, and Sorghum are from the West coast of Asia, (China and neighboring regions,) and they are cultivable more widely in our Appalachian Province.

Buckwheat, Oats, (?) WHEAT, Rye, Barley, Horse-beans, and TURNIPS (?) are from the drier regions and Plains of Central Asia and Eastern Europe; they will therefore probably find their most congenial lands in our Campestrian and Californian Regions. Wheat, and perhaps the other grains, have already reached a superior quality in California, and the "Wild Oats," a cereal from Europe, has been long naturalized, taking complete possession of vast tracts of the woodless hills.

The WINE GRAPE, (*Vitis vinifera,*) Peach, Apricot, Cherry, Muskmelon, Cucumber, Squash, (?) Pumpkin, Sunflower, Persian Tobacco, Spinach, (?) and "European Walnut," ("Madeira Nut,") were from the Regions of Southeastern Asia, resembling in climate our Uchitan and Arizonian Regions, with the Californian and Oregonian Regions, to some extent. The remarkable success of the grape in California is an evidence of the peculiar fitness of its climate.

The Cabbage, Radish, Horseradish, Pea (?), Clover, Lucerne, Plum, STRAWBERRY, Raspberry, Pear, APPLE, Quince, Gooseberry, Currant, Celery, Parsley, Parsnip, Carrot, Beet,

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of acres of the *unenclosed* heath, and literally I could not see a single Scotch fir except the old planted clumps. But on looking closely between the stems of the heath I found a multitude of seedlings and little trees, which had been perpetually browsed down by the cattle. In one square yard, at a point some hundred yards distant from the old clumps, I counted thirty-two little trees, and one of them, judging from the signs of growth, had, during twenty-six years, tried to raise its head above the stems of the heath, and had failed. No wonder that, as soon as the land was enclosed, it became thickly clothed with vigorously-growing young firs. Yet the heath was so extremely barren, and so extensive, that no one would ever have imagined that cattle would have searched it so closely and effectually for food."

The heaths of Europe are very similar to our "barrens" of the Western States, where the stunted trees, long kept down by fires, are now fast overtopping, and by their shade destroying, the smaller plants more peculiar to the barrens. Similar facts respecting our red cedar are stated further on, in the part relating to "Succession of Forests."

* "American Weeds and Useful Plants," by Dr. Darlington, new edition, edited by Dr. Thurber, 1859.

Onion, Asparagus, are all believed to be from Europe, and two of them, at least, have shown great superiority in the similar Oregonian and Californian Regions.

But as others are extensively naturalized in the Appalachian Province, where (deprived of its forests) we may believe that they also ranged entirely across the Old Continent, or really originated towards its Eastern side. The Red Currant is, in fact, circumpolar, and the Hop-vine also.

The Sweet Potatoe, American Tobacco, and Maize (or Indian Corn), originated in tropical America, and though pretty widely cultivable, especially in the Appalachian Province, have not become *naturalized* beyond the borders of the tropics.

The common ("Irish") Potato and Tomato were from Western South America, beyond the tropics, and find the most congenial climate in California and Oregon, the Tomato having become somewhat naturalized in the latter State.

The results of cultivation thus show that cultivated plants are in great measure subject to the same laws of climate as natives, including trees, and our knowledge of climatology, although still very imperfect in most parts of the world, may assist much in pointing out the kinds most suitable for trial in our new territories.*

But we see that many are cultivable far more widely than we might expect, chiefly such as are annual, their perfection being attained wherever the heat and moisture of the summer are sufficient but not excessive. Thus wheat produces up to lat. 60° along Mackenzie's river, but not at Sitka, lat. 57°, along the West coast, where the summer is too cool and moist. Maize, up to lat. 51°, at Lake Winipeg, but not in the cooler summers of the Oregonian Region, at lat. 46°.

One rule may be safely assumed as constant, namely, *that in proportion to the variety of trees naturally produced within equal areas, will be the variety of agricultural products and their relative success.* For the trees, where most numerous, require an amount of heat and moisture, which, regulated by agricultural experience, will suffice for the greatest variety of cultivated plants. The connexion is plainly shown in the great variety both of trees and crops produced in the Appalachian Province and extending over such large ranges of growth. The Nevadian, next in the variety of trees, cannot produce so many crops or in so large quantities even within equal areas.

Going from the Gulf of Mexico Northward, the heat becomes too little for one crop after another. Or going from the Mississippi West, a similar successive disappearance of crops must correspond with the disappearance of the trees and smaller plants, until about the 101st meridian, the point of extreme dryness (and winter cold?) having been reached, we find an absolutely barren desert. Thence West of the Rocky Mountains an improvement in climate and productions occurs, and a large though elevated tract among them will be found far more worthy of survey for the purpose of settling it than the deserts nearly two hundred miles wide East of it.

Further West, most of the Utah Region, with parts of the Shoshones and Arizonian Regions, again present us with irreclaimable deserts. For though excessive moisture can be avoided by choice of soil, the total want of it must, of course, be past remedy.

Wherever there is moisture enough for the cereal grains and grasses, it is probable that fruits may be cultivated along the streams, or by the aid of irrigation. On the high grounds the Red Cedar and Pitch Pine (62f) can be cultivated, or will spread naturally if fires are checked, even in the driest of the grazing lands, and South of lat. 35° the Mesquite (76) is also a valuable tree for timber and fuel, growing where probably no other can exist.

Grasshoppers, closely allied to the locusts of Asia, form a great obstacle to agriculture even along the Eastern border of the dry Plains, near the 97th meridian, having been very destructive at various points from Pembina, lat. 49°, to Austin, in Texas. In the settlements of Utah and even California they have also been injurious. From the various reasons connected with a dry climate, more of these dry regions will probably prove useless for cultivation than of those covered with forests.

Excessive moisture shows its effects injuriously to agriculture only partially, there being no regions so rainy within our territories as not to be adapted for some kinds of crops.

Considering the vast improvement which has been made in the cultivated plants by a long process of selection and attention, most of them having been, when wild, almost useless, the question arises whether many plants peculiar to each Region of our country, and therefore best adapted to it, cannot by cultivation be made *superior* even to the exotics on which we now depend, and which cannot be so well suited for new conditions as those plants always indigenous.

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* For an application of these rules to Nebraska and Washington Territory, see the chapter on Meteorology, in Suppl. to vol I, P. R. R. Reports, before quoted.

THE SUCCESSION OF FORESTS.

Some remarks on this subject, which has attracted so much the attention of the public and of botanists, seem requisite, as it bears upon the vexed questions of change of climate, and of the properties of soils.

The writer's own observations, as well as those of others, tend to the conclusion that this "succession" is more apparent than real, or that it is only temporary at most, where the soil has not been exhausted by agriculture.

In the North it has been observed that where the White Pine forests have been cleared off, a growth of deciduous trees follows: such as Red Cherry, Beech, and Maple; trees very sparingly scattered through the original forest, or sometimes so scarce as to seem entirely wanting. This growth flourishes for years, apparently to the exclusion of any of the former coniferous trees. But when it has become dense and tall enough to shade the soil, and thus to preserve its surface moisture, it has been observed that more or less of the Pines, Spruces, &c., were growing up under this natural protection.

These trees, being usually of slower growth, do not for a long time overtop the others, but the latter in about fifty years attain their limit of height, and *then* the long-lived and lofty Pines shoot above them, and, in their turn, make a dense shade, so complete frequently as to kill the "hardwood" trees which had so kindly protected them in infancy.

Further South, on the Alleghanies, we find a succession of a different and somewhat opposite character.

Where the original forest of Oak, Hickory, &c., is cut *on the drier soils*, there follows a thick growth of Red Cedar, which is often considered an evidence of an exhausted soil. If the land is pastured, no other tree may appear for years, *because cattle eat off everything else* as it springs up. But in time, as the cedars grow thick and tall, and protect the young deciduous trees both from the climate and from cattle, they will be found growing up thickly, and in about twenty years, when the cedar has attained its height, they overtop it, finally causing its death by their shade.

This "crowding out" of the cedar is remarkably shown along the rivers West of the Alleghanies, where it is usually so very rare in the luxuriant forest as to have become a favorite ornament around houses. But on these same rivers it may be seen growing along the edge of rocky precipices, places so *dry* and *barren*, that larger trees cannot grow there. These same starved and scraggy cedars, transplanted and allowed plenty of room, become ornamental trees.

Still further West, in the dry climate of Texas and the Dacotah Region, the red cedar becomes a prominent tree, covering large tracts where scarcely any other will grow. And in the Comanche, Wasatch, Yellow Stone, and adjoining Regions, it becomes, over vast districts, the only tree growth, and therefore of very great importance. On the bluffs of the Platte, Missouri, Canadian, and other rivers, it appears with trunks three or four feet thick, which, judging from its slow growth, must be of immense age.

These occur only where bluffs, bare rocks, or gravelly land have stopped the spread of fires, but serve to show that this useful tree might, if protected from them, be made to grow on many parts of the now treeless plains. On the islands of the Platte, thus protected and in good soil, it attains its highest development, the dry climate seeming well suited to it. Showing that it requires summer heat more than moisture, we find it growing at the East base of the Rocky Mountains in lat. 51°, while along the Atlantic it reaches only to lat. 43° in Maine. North of these limits a *low shrubby form* takes its place, considered by some identical, and reaching lat. 67° on the Mackenzie river.

In Utah, &c., as before remarked, it seems to be replaced by another *white hearted* species.

Again, in the extreme South successive growths of different trees follow the charring of the Pine forests, and the "Oldfield" pine is the first to reoccupy the exhausted tobacco lands, preparing the way for a return to the state of original forest.

The reason of this "succession" seems to be the same in all these instances. Some trees require much more shade and moisture during *the commencement* of their growth than others. The seeds, which lie on the surface or covered only by a thin vegetable mould, may not vegetate for years while exposed to the drying sunshine, or are killed by it immediately after sprouting. But, sheltered by other trees capable of flourishing in the driest and hottest sun, they gradually become established, and, as their roots go deeper, are at length able to derive moisture enough to counteract its effects.

On the other hand, the trees which served as their protectors die in their shade, leaving a great quantity of seed on the ground, which may lie dormant for an indefinite period, or, as often may be seen, grows and vegetates feebly in the *excessive shade and moisture*, until the death of the overshading growth occurs either from age, windfalls, or the axe.

Natural causes do not, however, usually cause extensive clearings, and we thus find these trees of various requirements very much mixed in our forests when their *rate of growth and height is similar*. It is in cases of great difference in these respects that a few species crowd out all others, as in the instances just given.

We therefore find that a partial clearing of the forest favors the growth of some, while it injures other trees by exposing the soil to the drying sun. Thus great changes in their local distribution may be effected by the settlement of a district, without considering the effect of partiality shown in leaving some kinds standing at the expense of others.

It has been before remarked that the nature of the soil has a minor effect compared to climates, its influence depending mostly on its ability to retain moisture at or near the surface, together with the regular supply of that moisture ; *for there is nothing in the mineral constituents* of any tree, (as shown by analyzing its ashes) which is not contained, to some extent, in almost every soil. The *presence* of deleterious substances, as *salt*, alkalies of some kinds, *sulphur*, and, perhaps, sometimes even *lime*, will prevent the growth of some or all of them. Yet even the great alkaline tracts of the Western plains, which exclude almost all vegetation, would probably, were there rain enough to dilute and diffuse the alkalies, become supporters of forests, as well as other vegetation. The absence of such tracts in other mountain regions of similar formation tends to show that rains and vegetation have prevented the accumulation of alkalies.

That climate is much more important to trees than soil is further shown by their growing *naturally* under very different conditions of the latter kind as long as the climate is suitable. It is unnecessary to mention specially such trees as the Red Maple, Red Cedar, Elm, several Oaks and Pines, which are so universally spread throughout the Appalachian and parts of adjoining Provinces, and in so various soils that it becomes difficult to determine which Region is the best adapted to them, or in which they most abound. Still more striking instances occur among trees of narrow range and usually limited to peculiar soils. Thus, on the *dry* soils of the Canadian Region we find the Spruces, and on the still drier and hot mountain slopes of Virginia the Rhododendron, both decidedly characteristic of their Region, and no where occurring together within each other's limits. But in a far different Region, and in a soil composed of scarcely anything but peat and vegetable mould, the "*Cedar Swamps*" (*Cupressus thyoides*) of New Jersey the botanist is surprised to find both of these, with many others, as strikingly Northern and Southern plants, growing abundantly and luxuriantly. It was in their early growth that the *moderated temperature* and *constant moisture* of the dark swamps were necessary to their existence. But after some years growth they are transplanted, and found to withstand the droughts, scorching sun, and frigid winters of the surrounding country, where they will not grow from seed without artificial assistance.

In the same way, and for a similar reason, we find almost all trees occasionally growing out of their Region, but in a *different soil.* If from a *moister* climate, they require a soil more retentive of moisture than that common in the Region ; if from a drier climate, they grow in the most sandy and porous soils.

A change from a warmer or a colder climate likewise requires a peculiar protection from the extremes of that in which they occur, and they, therefore, need either shade and moisture, or more sunshine and shelter from cold winds. These circumstances will probably account for all the differences in "station" observed in the distribution of trees in this country. Some which, in New England, grow only in the warm sandy soils near the coast gradually retire to the mountain sides as we go southward to Georgia ; while those of the New England mountain sides, growing in *dry* soil, but a *cool* and *moist* climate, become limited to cool, moist peat swamps as we go towards the warmer and drier South. Still, as shown by the lists, there is a sufficient number *limited* to each to characterize them, while those of more general distribution all have their favorite Region of greatest abundance.

INFLUENCE OF FORESTS ON SOILS.

Forests do not exhaust but increase the fertility of soils. This is evident from the productiveness of newly cleared lands, and would be still more apparent if the vegetable materials constituting the forest could be combined with the soil in a proper manner. For, since the great mass of all plants consists of carbon, which they absorb chiefly from the air through their leaves, it follows that their growth must be in proportion to the supply of this important element, provided the soil contains the necessary mineral ingredients. The gradual decomposition of vegetable matter at or near the surface furnishes the supply, and is doubtless the chief cause of the assistance afforded by manures, in which the decomposition is hastened by the mixture of animal materials. A forest cut off and the wood carried away removes an immense amount of vegetable material which, in the natural course of events, would have continued to decompose and furnish new forests indefinitely, beside being constantly increased by the addition of free carbon, derived from the atmosphere. The destructive custom of burning off woods decomposes the vegetation so rapidly that the carbonic acid formed is blown away and very little remains for the ensuing crops, so that in a few years the land is exhausted. The farmer is constantly carrying away the vegetable material produced, and, unless he returns it in the form of manures, he soon finds his labor unrewarded, although the land has lost scarcely any of its *mineral* constituents. The effect of the ammonia, so marked a constituent of manures, and a result of all *animal* decomposi-

tion, seems to be rather as a stimulant or *assistant* in the formation of vegetable growth than a *material*, since it does not exist uncombined in vegetable tissues. The same is the case with *Phosphorus*, so efficacious in Phosphate of Lime, and *Sulphur* in Gypsum, (Sulphate of Lime.) The amount of both these materials is inappreciable in most plants, and in those that contain them so small that they certainly do not need a fraction of the raw material furnished in these mineral manures. The Hydrogen in Ammonia, as well as in water, may be a more important substance, if plants have the power of separating it. But the *Carbon* derived from the decomposition of the carbonic acid in the atmosphere, and *constant moisture* supplied to the roots, are the most essential materials for the growth of all vegetation, though others are needed in *minute* quantities, either as *constituents* or *stimulants* to growth. Now, trees present a larger surface of foliage to the air than any other vegetation. Hence they must absorb more Carbon, provided the air around them contains much, and they are assisted by rain, &c.

Thus, a natural forest, in a damp climate, accumulates it upon the surface very rapidly, and lays up an immense stock for the future cultivator, which, in his heedless haste and wastefulness, is often more than half destroyed the first year that he may derive the benefit of the remainder.

To form an idea of the amount thus collected during the centuries of forest growth we need only study the progress of vegetation on a soil composed only of mineral substances. Such we may find either on the blown sand hills of the sea shore or, more strikingly, on the tops of mountains like those of New Hampshire, where there was originally nothing but bare rock, and nothing can have collected except from the air above. In such places (provided the climate is moist) we soon find the growth of the simplest forms of vegetation—grasses on the sea shore, lichens, and then mosses on the mountain.

On the *Alpine* summits, where higher vegetation will not grow, these plants alone have accumulated an astonishing quantity of carbonaceous soil, amounting to several inches, which must have all come from the air around them. The amount increases as we descend, owing to the greater luxuriance of vegetation, and, probably, too, the greater amount of carbonic acid in the air, as its weight carries it downward.

On reaching the limit of trees the amount which is found to have accumulated is rapidly increasing, and where fires have killed and partially burned the small trees, we find that they grew on *bare rocks*, which were concealed by the Vegetable mould of ages covering them, sometimes, for nearly a foot deep.

This continues to increase in quality towards the base, further augmented by that washed down by torrents from above, though from the rapidly increasing size and density of the *living forest*, the amount of unorganized carbon on the surface of the ground is less apparent. If all the vegetation of such a forest could be reduced to its elements, we should find the Carbon forming more than 99 per cent. of the whole, and the part supplied by the soil would appear quite insignificant.*

Now, to those acquainted with the first principles of Chemistry and of vegetable Physiology it will be evident that *all* this carbon must have been derived from the air. It there existed as carbonic acid, the result of vegetable decomposition, either slow or rapid under the effect of fires. In the latter case it is formed too rapidly to be all absorbed, and much must become diffused through the air and carried away by winds, for, being heavier than common air, it diffuses itself slowly, and when in excess tends to collect in hollows of the earth. Besides this source of waste, much is converted into charcoal, a form in which carbon is very slowly decomposed in the open air.

It has been already remarked that *abundant rains* are essential to forest growth, and the attempt has been made to prove it by the coincidence of their occurrence or absence. It may be further added that the *amount of vegetation of any kind* is in direct ratio to the amount of moisture in the air. This does not, however, prove that the rainiest climate is the most fruitful of agricultural products, since these are often plants suited to drier climates. Though the Prairies of the Illinois and Texan Regions may be too dry for forests to flourish as they do more Eastward, they still seem well suited for the growth of crops, some of which are the produce of plants originating in similar *plain* Regions of other countries. Wheat, rye, barley, and oats are believed to have been natives of the plains of Western Asia, which, as far as now known, have a climate and soil almost identical with those of our Plains.

The fires which from reasons already mentioned annually devastated these Prairies, or those East of longitude 97°, caused an immense accumulation of Carbon in its indestructible form of charcoal, and therefore, although the soil has every appearance of richness, it is found less productive of cereal grains than other soils apparently poorer. But, as is well known, these grains require much more mineral ingredients than most other crops; and

* If it could be shown that these Alpine summits once enjoyed a higher temperature, we might then believe that this accumulation of Carbon took place more rapidly from a more luxuriant vegetation, and that this has been destroyed by increasing cold. But the *distinct* character of the Alpine plants disproves this.

these minerals being covered by a thick bed of carbonaceous soil, must be reached and mixed with it by deep plowing to form a soil suited for such crops. Yet most roots and succulent garden vegetables require no more than the amount of mineral matters diffused through the mould from the destruction of the previous vegetation of the prairies.

May we not suppose that much of the luxuriance of vegetation in the Mississippi Valley is due in a great measure to the increased amount of carbonic acid carried down into it by the almost constant strong winds from the Western plains, while they are themselves deprived thus of the small amount produced by decomposition of their scanty vegetation? That it *is small* in so *dry* a climate (compared to the extent of surface) results both from the scanty vegetation and from the slowness of decomposition, for moisture not only assists vegetation by direct combination with its tissues, but by decomposing dead materials, and thus enabling them to be renewed in the growth of the living.

It is, then, scarcely to be doubted that forests have in all ages of the world acted as the chief accumulators of carbon in its purest state upon the surface of the earth. The amount found in the earth which can be accounted for in any other way than as a result of vegetable growth is very small, if any, while the immense beds of coal, peat, and allied substances are universally conceded to have once constituted living plants, and plants which in size and importance were equal to our most gigantic living trees. Some geologists have even thought it necessary to assume that in the remote ages of the coal forests the earth's atmosphere was so overcharged with carbonic acid that vegetation grew much more rapidly than now, assisted by the moist and hot climate which would accompany a world composed of numerous islands scattered through an almost universal ocean. Such a theory seems, indeed, necessary to account for the condition under which so much carbon existed before it was solidified, assuming that none has been added to or abstracted from the earth and its atmosphere.

We are now rapidly restoring this carbon to the air as carbonic acid, both by the burning of coal and of forests, while we are diminishing at the same time the means provided by Nature for its reparation and reorganization. The consideration of the effects of such an increase in the air of a gas absolutely poisonous to animal life leads to another important topic.

THE INFLUENCE OF FORESTS ON HEALTH.

Without attempting to discuss this subject fully, a few facts may be referred to as new or deserving further investigation.

It is a very common, reasonable belief, that *malaria*, in all its forms, is really some gas, and that which may be supposed at least a *constituent* of it, because found in almost every compound gas is *Carbon*, either as *carbonic acid* or *carburetted hydrogen*. Although the effects of these gases, when pure, do not correspond exactly to those of malaria, there is no doubt that long inhalation of them or their compounds in the air will injure the health, and perhaps may produce the effects of malaria. Many well-proved facts tend to show that malaria is decomposed by vegetation, and thus another analogy to the compounds of Carbon is established. The interesting experiments of Lieutenant Maury with sunflowers, by which the malaria, before prevalent, was completely excluded from the Observatory at Washington, showed that a plant *growing rapidly*, though not very high, was an effectual protection. These experiments were founded on observations accumulated during the last century and recorded in most works on malarious diseases, nearly all of which tend to show further the analogy of malaria to carbonic acid gas. It is heavier than the air; settles and accumulates in low places; is absorbed in passing over rivers, (carried by wind;) also by growing vegetation; abounds most in spring and fall when that growth is dormant; and is always considered a product of vegetable decomposition.

But there are likewise some facts which have been considered as evidence *against* these analogies.

First. It is not so prevalent in a wild, densely wooded country, as it becomes after a partial clearing of the forest.

But is not this because the forest excludes the sun light, thus retarding decomposition, while the luxuriant vegetation absorbs all the malaria produced by the decay beneath it. The great Cypress swamps of the South, half flooded at most times, are not unhealthy in their interior. Neither are the dense forests of Oregon, in a climate more rainy than any part of the United States, though not so hot in summer. But both these forests partly cleared become unhealthy, like the newly cultivated Western States. The hot sun hastens decomposition, and the heavy malaria lies near the surface because there is not sufficient vegetation to absorb it, and no wind to carry it away or diffuse it through the higher air, where the tree tops would do so.

Second. It disappears as a country becomes fully cleared, drained, and cultivated.

In this case the surface becomes dried and decomposition retarded; the winds have a free circulation and carry much of it off to nourish neighboring forests or to be absorbed by

waters; decaying vegetation is ploughed under and decays more slowly. In time the air becomes so purified that vegetation cannot derive much support from it, and the farmer must supply the want by manures, which, in decaying, furnish the desired carbon.

Thus, countries least productive are usually most healthy, like the great Western plains and the deserts of other lands, where there is a dry, pure air, and free range of the winds. But may not *moister*, *warmer*, and more fertile regions be made equally healthy by observing the means designed by nature to make them so?

Third. Tropical climates are notoriously unhealthy, although vegetation is more luxuriant and less injured by cultivation than elsewhere. Is not this because the great heat and moisture decompose vegetation faster than the malaria produced can be absorbed? These countries are in a condition resembling that of the Coal forest period, as supposed—there is an excess of carbonic acid in the atmosphere, and vegetation flourishes better than animal life.

Fourth. Malarious diseases do not affect cities, though they produce much carbonic acid by fires and animal respiration, and have *no vegetation* to absorb it. But they have a host of diseases, some of which arise from air poisons allied to malaria, and which are even more deadly. Does not the carbonic acid combine with other acknowledged *impurities* in the air, and these cause new effects on the human system?

Future experiments must determine what our present knowledge tends to show, that forests and trees are among Nature's great purifiers of the air, and as such should be protected and cultivated in this country much more than at present.

CULTIVATION OF TREES.

These observations on natural succession and growth of trees lead us to the consideration of their Growth in Cultivation.

This, at first sight, might seem to invalidate much of what has been said of the connexion between Regional distribution and climate; for every day may be seen around us trees of foreign or distant origin, flourishing as if in their native soil.

But let us see what new circumstances have been effective in their cultivation. They were either transplanted from the woods when of considerable size, or raised from seed with great care. The seed, instead of lying on the surface, was buried some inches, in moist, light soil, regularly watered and perhaps shaded, until the tender infant tree had sent its roots deep in the ground—a single day's neglect in watering or shading, would (and does) prove fatal to trees in this period of tender age—or in a soil too moist, or a rainy season, they may also fail to pass through one year. The young tree, well rooted, and its roots forming a dense "boll," (because they found abundant nourishment in the rich soil, and were not compelled to *spread out* for it,) is now transplanted and grows vigorously with little regard for the soil, provided it is moderately fertile.

It may blossom and bear fruit with all the luxuriance of its native forest or even more. But how few of its seeds ever grow unless accidentally or intentionally planted under favorable circumstances! It is in the *germination* and *early growth* of the tree that the effect of climate or of its substitute—*cultivation*—is apparent.

The effect of climate is also shown in these cultivated trees, by the fact that though they may flourish for years, a single season of excessive drought, or cold, may destroy the growth and labor of half a life time. From this we see that it is not the result of a few years which determines the *proportions* and abundance of various species in natural forests, but it has been the effect of the *average climate of centuries.* Now one and now another kind has preponderated, according to the nature of the season favorable to its growth.

Connected with this is the curious fact, before alluded to, that some foreign trees have found our country as well adapted to them as their own, reproducing themselves without cultivation. But how few trees from other regions of our own continent, *differing much in climate*, are thus naturalized. The foreigners come from a similar climate and are suited to ours, *though it could not produce them without the seed;* the latter were created for their region, and will not grow *spontaneously* out of it.

It is a common error to attribute to the influence of climate the differences observed in distinct, but nearly allied species of both plants and animals. We can easily imagine how it may affect the *size* of a tree, but that it can essentially and permanently alter the *forms* and *proportions* of its various parts, is an assumption of which we have no evidence. The numerous forms of the Oak, Hickory, Pine, &c., were undoubtedly created *for* the conditions in which they exist, but certainly not *by* those conditions. The *varieties* produced by cultivation, when the condition of soil and often of climate are entirely changed, can hardly be balanced against the law of Nature, which is that, *left to themselves*, all forms of life follow certain *specific* and *fixed* types, from which a variation beyond a very limited extent is a rare exception, and not one to be perpetuated for a long period. This applies to *permanent and natural varieties*, (so called,) as well as to recognized species.

But by placing plants under the best possible circumstances, and by carefully selecting from the varieties produced in this way those best suited for his use, man has, in a long series of ages, obtained the many forms of improved fruits now in cultivation, but which, left to themselves, return in one or two generations to the form of the original species, usually almost useless to him. How much we may expect from the improvement of our many native fruits is foreshadowed by the excellence already attained by our grapes and blackberries. Europe had no fruits naturally so good as our Papaw, Persimmons, or Grapes, when our present cultivated fruits first were cultivated.

There are many facts connected with the cultivation of trees which serve to throw light upon the relations of climate and forest growth; but time and space will not admit of their discussion here.

The general laws of Nature have been sufficiently stated, and their illustration with respect to each species may form the subject of an extended work when more experiments shall have been made.

We have already trees from the extreme South growing well in the latitude of Boston, and it is already demonstrated that nearly all those of the United States may be cultivated in almost any part of its vast territory. Yet much remains to be done in experimenting on those of the Pacific side of the Continent, many of which will be found extremely valuable. And, indeed, so much remains to be done that the science of Arboriculture, already a national interest in Europe, where the forests rank among the most valuable government property, is still almost unknown here.

Another generation will need a much greater supply than is likely to be furnished by the forests left to it by the present, especially in the vast woodless Regions of the West, where a few far-seeing agriculturists are even now cultivating forests with commendable attention.

The chief error both with them and with those who plant or preserve the forests further Eastward is a tendency to over-partiality in their choice of trees. Although some are certainly of more general use than others, yet we must remember that in the economy of Nature none were created in vain, and there is not, I believe, *one* among the 180 species of the Eastern States already enumerated, which has not its use either in agriculture, arts, or sciences. And now applications are constantly arising, so that we cannot say what tree, now neglected or destroyed, may soon become of great value. The great superiority of our mechanics, in the construction of everything made of wood, is, in a great measure, due to the extensive choice of materials furnished by our unrivalled forests; and were experiments scientifically conducted so as to determine the relative properties of all woods, much might be expected. We still know nothing of the value of many of our trees, and of those which might be cultivated profitably here.

The immense woodless plains on which the climate may forever prevent the natural growth of trees *from seed* may be made, *by the aid of their cultivation while young*, to produce all that will ever be needed for all purposes.

Such experiments in both the culture and properties of trees are worthy the attention of our general government; for, though promising great results, they are too expensive for private enterprise.

The position of Washington is, too, particularly favorable for them, situated as it is near the boundaries of two Regions—the Carolina and the Alleghany—while about ten of the most Southern trees have their Northern limits along the coast near Chesapeake bay, and full fifteen far Northern species reach the same latitude along the higher Alleghanies. Every tree, not only of our country, but of all temperate climes, may be cultivated at this natural (as it is the political) centre of the Union.

To what more appropriate and important use could those consecrated acres, the home of WASHINGTON, be applied, than to the formation of a Grand Park, where the great natural elements of our national strength should be collected and preserved for the admiration and benefit of posterity?

How could the spirit of Washington's example be better followed than by devoting to the improvement of our natural and agricultural resources those lands hallowed by the residence of him who declared Agriculture the noblest of arts? And there is enough room for the cultivation of whatever other plants may require trial for the public benefit, as well as for the Botanic Garden, where the virtues of plants now neglected may receive investigation.

What monument erected by human skill could be compared to a forest of gigantic trees, like those of Maine, Mississippi, and California, which have outlived the empire of Rome with all its grandeur of architecture, and may yet live after all modern nations have become lost in the history of the past? Future generations might sit beneath the somber shade of the Pine, Cypress, and Sequoia, mingling their branches hundreds of feet above the tomb of Washington, and say: "These trees were planted by our ancestors, and have been raised to their present height by the Creator, while yonder marble monument has crumbled to the earth. Here are the links that connect the Present with the Past, for the Park is the *living* memorial of Our Country's Father, preserved to us since the early days of this great Republic by the patriotism of our mothers."

TEA:

ITS CULTURE AND MANUFACTURE; WITH DIRECTIONS FOR THE SOIL, CHARACTER OF CLIMATE, ETC., ETC., ADAPTED TO THE CULTURE OF THE PLANT IN THE UNITED STATES, FROM PRACTICAL EXPERIENCE, ACQUIRED BY A RESIDENCE OF SIX YEARS IN ASSAM.

BY SPENCER BONSALL, OF PHILADELPHIA, PA.

Assam is situated on the Northeastern extremity of the British possessions in India, and bordering on Birmah, China, and Thibet, from which it is separated by lofty ranges of mountains. It lies diagonally between the latitudes of 25° 50′ and 28° 20′ North, extending from 90° 40′ to 97° 20′ East longitude. Its length is about 500 miles, and its mean breadth about 60 miles, covering an area of 30,000 square miles. The valley is intersected in its whole length by the great river Brahmapootra.

All the tea localities lie to the eastward of the 94th degree of longitude, in Upper Assam, and are supposed to extend, with the exception of short intervals, to the province of Yunnan, one of the principal tea-growing districts of China.

The tea-plant was first discovered to be indigenous to Assam some time previous to the year 1826, by Major Robert Bruce and his brother Mr. Charles A. Bruce. No particular attention, however, was paid to the discovery until the year 1834, when a Tea Committee, appointed by the East India government, decided on its being the genuine tea-plant. A few Chinese tea-plants and manufacturers were afterwards brought to Assam from China, and in the year 1837 the first consignment of Assam tea, consisting of 46 boxes, was despatched to Calcutta.

In the month of February, 1839, the Assam Company was formed in England, with a *present* capital of £500,000, in 10,000 shares of £50 each; 8,000 shares were set apart for allotment in England, and 2,000 for allotment in India.

Cotemporary with the formation of the Assam Company in England, an association, having the same objects in view, was formed in Calcutta. Subsequently, however, both the companies agreed to merge their interests and form one association, under the style of the ASSAM COMPANY, the management of which in India should be vested in a Committee of Directors chosen by the Bengal branch of the Association.

The Company had at first many difficulties to contend with. The country was almost entirely covered with a dense tree jungle,* and with such a sparse population, that it became necessary to procure several thousand coolies or laborers from China and Bengal, the latter from a distance of from 500 to 600 miles from the tea districts; a journey of three months by water; the only mode of communication. Provisions and stores of all kinds had to be procured from a distance; the jungles cleared; roads and bridges constructed; buildings erected, &c., &c. In addition to this the Chinese sent to us proved almost entirely worthless.

It seems to be a prevailing idea that all Chinamen understand tea-making. We might as well suppose that all Americans know how to prepare chewing tobacco, or any other production of the country. It is probable that out of the large number of Chinese in California and other States of the Union, not a half dozen men could be found that had ever seen the process of tea-making. The Chinese usually met with (outside their own country) are from the cities and towns near the sea coast. The tea districts being in the interior, many hundred miles from the coast, it is not probable that many of the manufacturers ever find their way to it. Mr. Samuel Ball, "late Inspector of Teas to the Hon. United East India Company, in China," after having resided in that country for a period of twenty-two years, states in a note, page 105 of his work:

"I wish the reader particularly to understand that I have never seen tea made for sale, or which was fit for sale. The tea districts are distant eight hundred or more miles from Canton."†

I here give an extract from the "Report of the Local Directors," Calcutta, 1841. "The large gang of Chinese laborers, noticed in the last report as having arrived from Singapore, gave a great trouble before proceeding on the voyage upward. The selection of them by the Chinese agent sent down for the purpose had been grossly unattended to, and worthless characters were sent up instead of useful and steady artisans. They departed on the 3d of March, 1840, under charge of Messrs. Milne, Powles, and Hart. On their arrival off the

* Jungle, a *Hindoostanee* word signifying a dense forest, a thicket, brush wood, &c., or coarse, reedy vegetation, anything growing wild or without cultivation, such as a jungle of weeds, &c.

† See also Agricultural Report of the Patent Office, 1857, p. 179.

Station of Pubna an affray took place in the bazär, between the Chinese and Bengalees, in which death ensued, and 57 of the Chinese were consequently kept in jail for trial by the magistrate of that district; but so many difficulties occurred that the trial did not take place until the 8th of June, when nothing could be proved against any of them. In the meantime the remainder of the gang could not be induced to proceed without their countrymen, and when these were released, they demanded a further advance of pay and supplies of opium and provisions. But as great expense had been incurred by their contumacy, they were informed that, unless they would at once proceed under their engagements, such obligation on the part of the company would be considered as cancelled, and they would be at once abandoned to their fate. They would not yield; we had but little power over them, and they were consequently discharged on the spot, and the assistants proceeded direct to Assam without them. It was greatly to be regretted that so many lawless characters should be let loose upon society; but without a further heavy expense on the part of the Company it could not be avoided. The total loss upon this gang, from wages, passage money, and boat hire, has amounted to Company's Rs. 29,365:3:11 ($14,682.) But as the other Chinamen who did reach the stations at Assam turned out so ill, and were of so little use, and have so many of them since taken their discharge, this loss has perhaps been less than it might have been, had they consented to join the station. Another very serious disappointment and loss arose partly from the *cholera* breaking out among the gang of 652 Dhangah coolies, about half way on their march from Hazareebaug to Assam, but more particularly, it is feared, from the gross inattention of the assistants in charge. The whole gang disappeared in one night, and no trace could be found of them. The loss upon these men has been Company's Rs. 10,727:6:2 ($5,363.) To these misfortunes may be added a great mortality during the past most sickly season in Assam, and the unfitness for such labor of a large proportion of the laborers sent from hence and from Chittagong. The Rungapore coolies, however, turned out well, and further gangs have been sent from that district."

Fortunately for the company, about 300 of the Chinamen who did arrive at Assam died of *cholera* or *jungle fever*, and a number more ran off or were discharged, leaving a few first-class artisans, such as green and black tea makers, lead canister, paper and box makers, packers, &c., by whom the Europeans and Assamese employed by the company were thoroughly taught all the branches of the business. The last of the Chinese were discharged the service in March, 1844, and glad we were to get rid of them; the natives of the country being equally expert when taught, much more docile and easily managed, and what was of more importance, worked for less than one-third the wages.

I annex a copy of the agreement of *Tsay-yun-Mooy*, Chinese paper maker. This is a sample of all the others:

"Tsay-yun-Mooy hereby gives this contract, to the end that he thoroughly understands the art and trade of making paper for packing tea, and now Mr. Matheson having requested him to proceed to Assam, there to exercise his handicraft, the term of five years is hereby agreed upon; at the expiration of which he shall be permitted to return home. It is clearly understood that he shall receive for wages fifteen Spanish dollars ($15) per month, board included.

"He shall also receive three months' wages in advance, being forty-five dollars, ($45,) as bargain money, and his wages are to commence counting from the day that he goes on board ship.

"He must exert himself to the utmost in his employer's service, and may not be slothful or lazy. While the term of five years shall not be expired, he may not clandestinely work for another. Should he violate this contract he shall be fined a hundred dollars, ($100,) which he must pay over to his employer. The term of five years being duly expired, he may, on no account, be forcibly detained, but shall be permitted to return home if he so wills it.

"His passage money, going and coming, expense of victuals on board ship, &c., &c., are all to be defrayed by Mr. Matheson.

"He also hereby acknowledges to have received the above forty-five dollars, ($45.)

"Twonkwany, 20th year, 1st moon, 9th day.

"Macao, 11th February, 1840."

On the back of the above is the following, in which, although there is a slight error of one year in the calculation, the company did not lose by it:

"Tsay-yun-Mooy hereby agrees to serve the Assam company for the unexpired time of the agreement on the back hereof, namely, from 1st May, 1841, to the 1st day of March, 1844,

being three years and ten months, at the monthly pay of fifteen Spanish dollars. Ex: a 220,14, Co's Rs. per 100 Spanish dollars, to be paid monthly, without deduction.

"He also agrees to work at tea-making whenever he may be ordered to do so.

"Signed in the presence of—

"THOS. WATKINS,

"*Superintendent Government Tea Plantations.*

"CHUBWAH, 5th May, 1841."

True copy.

S. BONSALL.

JAIPOOR, March 4, 1844.

An inconsiderate expenditure of capital in other ways placed the Company in great jeopardy, and at one time it was feared the scheme would have to be abandoned. The number of managers and assistants appointed by the Assam Company to carry on their affairs and superintend the *tea barries*, or gardens, on large salaries, was quite unnecessary. Three or four experienced European superintendents to direct the native establishment would have answered every purpose. The number employed was twenty-five.

A steam saw-mill was procured from England and sent to Assam, where it arrived in the year 1841. It was intended for cutting thin boards for tea boxes, &c. The cost of this machine was Company's Rupees 10,426:11, ($5,213.) It was placed under a shed at Jaipoor, where it remained, boxed up, until 1846, when it was sent down to Calcutta and sold for a mere trifle.

A large iron steamboat, with a pair of engines of fifty horse-power each, was received in Calcutta in April, 1841, and after being put together under the superintendence of the engineer and boiler-maker, who were engaged in England for the purpose, it was frequently sent up and down the Brahmapootra river from Calcutta, carrying little else than a few thousand rupees for the payment of the establishment in Upper Assam, which might have been transmitted through native bankers, and saved the company the most lavish and unprofitable expenditure of capital. The cost of the steamer was about Company's rupees 1,10,000—*one lac and ten thousand* ($55,000.) There was also a wooden flat or barge, costing Company's Rupees 14,000 ($7,000.) This was for the purpose of carrying passengers, when any could be found, which was not likely to be of very frequent occurrence, as the entire European population of Assam, male and female, did not exceed fifty persons. The flat was towed by the steamer.

Near the close of the year 1846 it became necessary to make a vast reduction in the expenses of the Company. Nearly all the factories were closed, the plantations abandoned, and the Europeans dismissed, retaining only two to take charge of the implements, &c., on hand, and carry on the manufacture of tea on a small scale. Since that time the Company has gradually resumed the working of some of the *barries* or gardens, and, I trust, will eventually regain all that was lost.

The TEA PLANT is thus described by botanists:

Thea viridis, Linn.; *Camelia theifera*, Griff.* (Chinese, *chah;* Assamese, *phalap.*)—The ordinary height of the cultivated shrub is from three to six feet, though the wild plant attains a far greater size. It is a polyandrous plant of the natural order *Ternstiomicoe.* The flowers, which open early in the spring, (appearing upon the plant about a month,) are smaller in size and much less elegant than those which render some species of the Camelia so attractive. They are slightly odorous and of a pure white color; they proceed from the axils of the branches, and stand on short foot-stalks, at the most two or three together, but usually solitary. There are five or six imbricate sepals or leaves supporting the blossom, which fall off after the flower has expanded, and leave from six to nine petals surrounding a great number of yellow stamens, that are joined together in such a manner at their bases as to form a sort of floral coronal. The seeds are enclosed in a smooth, hard capsule, of a flattish triangular shape, which is interiorly divided into two, three, and even five cells, each containing a firm, white, and somewhat oily nut, from the size of a pea to that of a hazel nut, of a nauseous and bitter taste. They ripen in some localities as early as October, in others not until January. The stem is generally bushy, with numerous branches bearing very dense foliage, and in its general appearance not unlike the myrtle, though not so symmetrical as that plant. The wood is light-colored, close-grained, of great comparative density, and, when freshly cut or peeled, gives off a strong smell, resembling that of the black currant bush. The leaves are alternate, on short, thick, channeled foot-stalks, coriaceous or leathery, but smooth and shining, of a dark green color, and a longish elliptic form, with a blunt, notched point, and serrated except at the base. It is needless to men

* Dr. Griffith, botanist in the service of the "Honorable East India Company."

tion that these leaves are the valuable part of the plant. They are, however, a good deal affected by the site in which the plant is grown, whether under the thick umbrage of large trees or in open spot exposed to the influence of the sun's rays, as well as by the nature of the soil in which the plant is found.

The districts in which the finest tea is produced in China lie between the 25th and 33d degrees of latitude; and in Assam the ranges in which it has been discovered are between the 27th and 28th parallels, or almost centrically situated within those limits which experience has proved the most favorable to the development of the plant.

Almost all the tea localities occur within very short distances of each other, and are very limited in extent, although some tracts are further apart and cover a greater extent of land than others. These localities may be characterized as presenting an excess of humidity, and are, in almost every instance, clothed with excessively dense tree jungle. The chief characteristic of the localities is their intersection, in every direction, by numerous ravines and hollows, varying in breadth from three to two hundred feet, the spaces between which often assume a conical shape. The presence of these are proofs of the lightness of the soil. Dr. McClelland* seems to attribute them to the action of the water collected in the foliage of the surrounding trees, and thence precipitated in heavy volumes. The plants seem undoubtedly to thrive best near small rivers and pools of water, and in those places where, after heavy falls of rain, large quantities of water have accumulated, and, in their struggle to get free, have cut out for themselves numerous small channels.

The tea, in its wild state, can hardly be called a *plant*, but a *tree*, with a trunk eight to ten inches in diameter, and reaching, in many instances, to the height of thirty or forty feet, rearing its long stem among other trees of the forest, all of which seem to be striving which shall first raise its head above the dense under jungle of creepers and canes, and pierce into the light above. It is true there are some smaller shoots and seedlings springing up at the feet of these forest tea trees, but they cannot even be seen, nor indeed can this forest be entered at all, without cutting out the path you wish to tread by *daws*, or billhooks.

It was by the increase of these pathways, made by the natives of the country, in pursuing their frequent journeys by the shortest routes, and by offering rewards, that so many of these localities were discovered. The under jungle was then removed to ascertain what number of small trees or seedlings existed, and when found in sufficient abundance a general clearance of the forest was made, the tea trees cut down to within a foot or two of the ground, and the vacant spaces filled with plants brought from a distance. The place was then named from some local object or circumstance, such as *Hookun-jury Barrie*, (Dry-brook Garden,) *Hattie-mora Barrie*, (Dead Elephant, or, literally, Elephant Dead Garden,) &c.

Young and vigorous shoots were thrown out by the trees that had been cut down, producing leaves of enormous size. I extract the following memorandum from my journal:

"*May* 5.—This morning one of the Tecklas brought in from Ridingia Barrie a few tea leaves measuring as follows in length and breadth: 11 inches by $3\frac{6}{10}$ inches, 10 by $4\frac{2}{10}$, 10 by $3\frac{8}{10}$, $10\frac{2}{10}$ by $3\frac{6}{10}$." The ordinary size of the full grown leaf is from 3 to 4 inches in length by $1\frac{1}{2}$ to 2 inches in breadth.

These very large leaves were quite young and tender, and by chopping them in pieces, an inch or two in size, they could be made into very fair tea, but not of fine flavor, being too rank and full of juice.

About the third year after clearing the *Barries* were in good working order. The shoots from the old trees, being topped, sent out numerous branches, forming a fine bush, which was never allowed to grow higher than about six feet, or out of reach of the hand.

For filling up vacancies in the old *Barries*, or in forming new ones, some of the natives were employed to search the jungles and bring in any small plants they might find, for which they were paid at the rate of one rupee, or about fifty cents, per hundred; but it was soon found that this plan would not answer. The rascals, finding it much easier work, would go at night into the *Barries* that were in charge of one of the Europeans, steal a lot of his plants, and the next day sell them to another, who, after having the plants carefully set out, would go in a few days to see how they were getting on, when, to his astonishment, he would find that they had all disappeared, having been sold to some one else. This was soon put a stop to, however, by refusing to purchase plants at any price, sending our own men for them when they were required.

The prevailing characters of the soil are lightness and porousness, and its prevailing color is yellow or reddish yellow, which generally becomes more developed as the depth increases, up to a certain point, when it passes into sand.

Dr. McClelland is of opinion that the requisite quality of the soil, which is, comparatively, of rare occurrence, will account for the manner in which the plant is distributed in spots or distinct colonies, instead of being uniformly diffused with the common vegetation.

* Dr. McClelland, geologist in the service of the Honorable East India Company.

The component parts of the soil, he observes, consist of—

Free water	22½
Water of absorption	3
Vegetable matter	16
Oxyd of iron	6
Alumina	6½
Silex in the state of fine dusty sand, or coarse sharp sand, and dusty matter.	130
	184

The soil of those portions of the Naga hills, on the Southeastern boundary of Assam, on which the tea tree is found, contains, in 200 parts—

Water	37
Fresh fiber	1
Vegetable matter	5½
Silex	135
Alumina	11
Oxyd of iron	4½
	194

Mr. Piddington,* who has had an opportunity of comparing and analyzing the tea soils of Assam, and those of China, gives the following result:

Tea soil of Assam.

	Surface soil.	At 2½ feet deep.	Tea soil of China.
Water	2.45	2.00	3.00
Vegetable matter	1.00	.80	1.00
Carbonate of iron	7.40	6.70	9.90
Alumina	3.50	5.45	9.10
Silex	85.40	84.10	76.00
	99.75	99.05	99.00
Traces of phosphate and sulphate of lime and loss.	.25	.95	1.00
	100.00	100.00	100.00

"The two peculiarities in these soils," observes Mr. Piddington, "are, first, that they contain no carbonate of lime, and only traces of phosphate and sulphate, and the next, that their iron is almost wholly in the state of carbonate of iron, a widely different compound from the simple oxyds. They would be called poor yellow loams; and cotton, tobacco, or sugar-cane would probably starve upon them, but we find that they suit the tea plant perfectly. It is a striking coincidence that we should find our tea soils and those of China so exactly alike."

Mr. Ball had several specimens of Chinese soil analyzed by Professor Faraday, which were obtained, "through different channels, from the Province of Fokien, some from the Bohea district. They were procured by respectable parties; but what dependence can be placed upon them as being true or good specimens, I cannot determine."

* Henry Piddington, Curator of the Museum of Economic Geology of India and of the Geological and Mineralogical Departments, Asiatic Society Museum, Calcutta.

The following is Professor Faraday's communication to Mr. Ball :

ROYAL INSTITUTION, May 11, 1827.

SPECIMENS OF EARTHS FROM CHINA.

No. 1. Specimen from the Lapa, a hill near Macao.
No. 2. Specimen from the Northeast part of the province of Fokien.
No. 3. Ditto.
No. 4. Taken out of a pot containing a tea plant from the Bohea country.
No. 5. Bohea country, 1st quality.
No. 6. Bohea country, 2d quality.
No. 7. Bohea country, 3d quality.

These earths were all of similar ferruginous tints, *i. e.*, of light yellowish or reddish brown, as the one formerly analyzed, except No. 2, which was of a grey or brownish grey tint. They were all of a clayey adhesive character, but easily crumbling and falling down in water. None of them contained worn pebbles or worn sand, though some included fragmented stones, and all of them sharp, tabulous, silicious particles. None of them gave evidence of containing carbonate of lime except one, and in that only a single piece of the carbonate was observed, which was probably accidental. Their hygrometric state appeared to be about that of the former sort, viz: 102.

No. 1 contained no stony fragments or pebbles ; the aggregated portions were, however, irregular and dissimilar, being of different colors, as if the soil had either been purposely mixed with other soil, or else cultivated and manured. It contained also a few loose fibers. It contained also a trace of sulphate of lime.*

No. 2 contained fragments of apparently a decomposing porphyritic rock ; it was in this that the fragment of carbonate of lime occurred. It included also several pieces of charcoal, and a few portions of old decayed vegetable fibers.

No. 3 included some long woody fibers, and a few irregular fragments like those of No. 2.

No. 4 contained very few vegetable fibers, some angular fragments of decomposing granite and felspar, and particles of mica diffused through the soil.

No. 5 contained very few fibers ; no appearance of pebbles or of mica ; but, by washing, a few heavy, greenish-black mineral particles were found, which had not before occurred.

No. 6. A few fibers ; no stones, much mica in a finely divided state, but no green particles.

No. 7. A few long, loose, woody fibers ; a few small silicious stones ; particles of mica, and a recurrence of the same green particles, as in No. 5.

The proportions of sand in these soils varied very much, as may be observed in the following table. The clay, &c., includes not only the argillaceous particles, but destructible matter and water:

	Lapa.	N. E. Fokien.		Pot.	Bohea.		
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
					1st qual.	*2d qual.*	*3d qual.*
Sand	46.1	17.70	10	51.54	33.08	44.61	36.15
Clay, &c., (ferruginous.).	53.9	56.53	90	48.46	66.92	55.39	63.85
Fragments		25.77					
	100.00	100.00	100	100.00	100.00	100.00	100.00

"*Chemical Analysis of the earth of a Japanese Tea Plantation, by Dr. Th. Fc. L. Nees Von Esenbeck and L. Cl. Marquart.*†

"The earth given to us to analyse appeared a very uniform fine-grained mixture of a yellowish grey color, having altogether the appearance of a strong ferruginous clay, in which no mixture of sand was perceptible to the naked eye. After the removal of two small stones, one porphyry and the other grauwacke, the weight of the earth amounted to 462 grains. The specific gravity was decided at 2.235. 200 grains of air-dried earth absorbed 165 grains of water. Of this water, in the first five hours, under a temperature of from 15° to 18° Reau-

* This soil had been manured with goat's dung, and was taken from the small plantation at the Lapa, described by Dr. Abel.
† See Von Siebold's Nippon, Part VI, p. 17.

mur, 31 grains were lost; after 24 hours, 100 grains; after 48 hours, still 24 grains remained; and not until after 72 hours had all the water disappeared.

"Of these 200 grains the parts soluble in cold water amounted to scarcely one-eighth of a grain, consisting of humus and lime, with traces of muriatic and sulphuric acid, clay and iron."

(Then follows a minute description of the analysis giving the undermentioned result.)

On placing together the constituent parts of the earth, we find the following results. One hundred grains of the earth contain:

Silicious earth	53	grains.
Oxyd of iron	9	"
Clay	22	"
Oxyd of manganese and magnesia	0½	"
Gypsum	0½	"
Humus	1	"
Phosphoric acid traces of hygrometric water	14	"

He adds in a note: "On another portion of the earth we succeeded in proving evident traces of kali. It does not appear, however, as a fresh soluble combination of salt in the earth, but is undoubtedly combined with clay and silex.

"After we had by these means analyzed the earth in its constituent parts, it appeared that it should be considered as an intimate mixture of silicious earth and clay, with the oxyde of iron and manganese, (eisenhaltiges Aluminum-silicat.) The small portion of magnesia is remarkable, and even this is closely combined in the soil with the silicate mentioned.

"Thus the earth appeared like atmospherically dissolved slate. The phosphoric acid is well combined, and arises probably, as well as the gypsum, from the manure in the soil. According to Thaer's classification of soils, this earth belongs to the third class, as a strong sandy clay soil.

"The analyzed earth is, moreover, from its deficiency in carbonic acid, humus, lime, and magnesia, not to be referred to the productive, and assuredly requires stronger manure, and addition of alkaline matter. Its water-retaining property is considerable on account of its great portion of clay, but the soil is deficient in lightness from the absence of coarse sand."

With regard to humidity, Assam may be considered to enjoy the maximum. The rains are of long continuance; they commence in March and last till about the middle of October.

The cold season is characterized by the daily presence of very heavy fogs or dense vapors, which arise for the most part from the rivers and marshes, about daylight, and continue to increase for a couple of hours, when they begin gradually to ascend, leaving everything saturated with moisture.

The following table shows the average result of several years' observation, taken by myself, in Upper Assam:

	Temperature.			Number of days on which rain fell.
	Minimum.	Maximum.	Mean.	
	Deg.	*Deg.*	*Deg.*	
January	50	73	60	5
February	54	76	62	8
March	55	88	74	14
April	60	90	76	17
May	60	92	77	20
June	70	91	77	23
July	75	88	82	21
August	74	91	81	18
September	72	90	80	15
October	66	87	78	11
November	56	80	72	4
December	52	73	61	6
				162

The lowest range of the thermometer I ever noted was 48°, the highest 101°, but this was a rare occurrence.

My opinion is that the climate is not of much importance to the successful cultivation of the tea plant, provided the cold weather is not of long continuance, and the temperature does not fall below 10° or 12° of Fahrenheit. In proof of this, I may state that I had a tea plant growing in the open air, in this city, (Philadelphia,) without any protection whatever; it was occasionally covered with snow, and surrounded with ice during the winter, and sometimes the leaves appeared to be frozen stiff, but in the spring they were as fresh and green as ever, not one of them falling off. The plant grew well until the next winter, which was very severe, the thermometer showing a temperature of several degrees below zero. This killed the tea plant, as it did many fruit trees.

Should it be found on trial that the tea seeds can be ripened in the open air, in the Southern part of the United States, there can be little doubt but that by planting them each year a little further North, the plant will, in the course of time, become much more hardy. In an article on the Cultivation of *Rice*, published in the Farmer's Encyclopedia, 1844, it is stated that, "from long culture in a comparatively cold country, the German rice has acquired a remarkable degree of hardiness and adaptation to the climate; a circumstance which has frequently been alluded to as an encouragement to the acclimating of exotics. 'It is found,' Dr. Walker remarks, (Essays on Nat. Hist.,) 'that rice seeds direct from India will not ripen in Germany at all, and even that Italian or Spanish seeds are much less early and hardy than those ripened on the spot.'"

In some of the tea districts of China snow falls to the depth of several feet, and the teas made in these districts are much superior in flavor to those made in a more temperate climate.

"The climate found the most suitable at Java for the cultivation of tea is that of the mountainous regions situated at 3,500 to 4,000 feet above the sea, where the air is so cool that Fahrenheit's thermometer at sunrise indicates 58°, and 74° at two o'clock in the afternoon. On still higher elevations, even 5,000 feet and more, the tea will be highly flavored; but in lower districts the flavor deteriorates in proportion as the situation is low."*

The elevation above the sea of Jaipoor, in Upper Assam, is only 254 feet, although the distance by water to the ocean is about 1,000 miles. A majority of the *Barries* cultivated are at about the same level; the highest of them, Hookim-jury, is but 600 feet in elevation.

Botanically considered, the tea plant is a single species; the green and black, with all the diversities of each, being mere varieties produced by a difference in the culture, qualities of soil, age of the crop when taken up, and modes of preparation for the market.

Considered as an object of agricultural produce, the tea plant bears a close resemblance to the vine. Skill and care, both in husbandry and preparation, are quite as necessary to the production of good tea as of good wine.

Fig. 1.

Manufacture of Black tea.—Should the season prove at all favorable, *i. e.*, if one or two showers of rain should have fallen in the early part of March, the young leaves rapidly put forth, and as soon as each shoot has produced four or five leaves, about the 15th or 20th of the month, they are in a proper state for plucking. This is done by men, women, and children, each furnished with a small open-worked basket, capable of holding from three to four pounds of leaves. Only the young and most tender leaves are taken; the old ones are fit for nothing, as they are too tough to admit of being rolled.

The pluckers first nip off with the thumb nail and middle of the forefinger the three first leaves together, *a*, *b*, *c*, (fig. 1,) at the place shown by the dot-

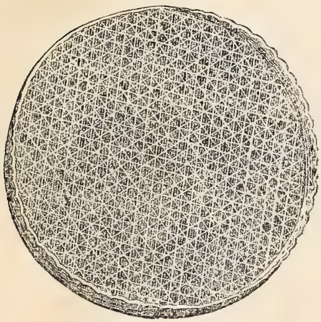
* Ball, on the cultivation of tea in China, p. 39.

ted lines; then *d*, *e*, and *f*, separately, leaving the small buds behind the leaves to form shoots for the next crop. It is very seldom that more leaves than these are taken, unless they feel soft and tender. It is very necessary to pluck all the shoots from the tree, for should any be omitted, particularly in young and fresh pruned trees, the loss is not confined to a single crop, but affects all the succeeding crops, and may even cause a loss the following year by rendering it necessary to cut all such shoots back, as they generally run up to long, slender branches; whereas if stopped when at a proper length for the first crop, each shoot would send out three or four new shoots for the second crop, and so in the second or third crop, and the tree be kept within proper bounds.

Sometimes the trees suffer from the opposite extreme, namely, picking the leading buds off before the shoots are of sufficient length to produce three or four buds for the next crop or season; when thus prematurely picked the trees become stunted, and the only remedy is heading down, as in the other case.

The leaves should not be allowed to remain long in the basket; they should be placed in lightly, and occasionally turned with the hand, or they will become heated, which will spoil the flavor of the tea. The baskets should be taken to the tea-house every hour or two, where the leaves are weighed and the pluckers return to their work.

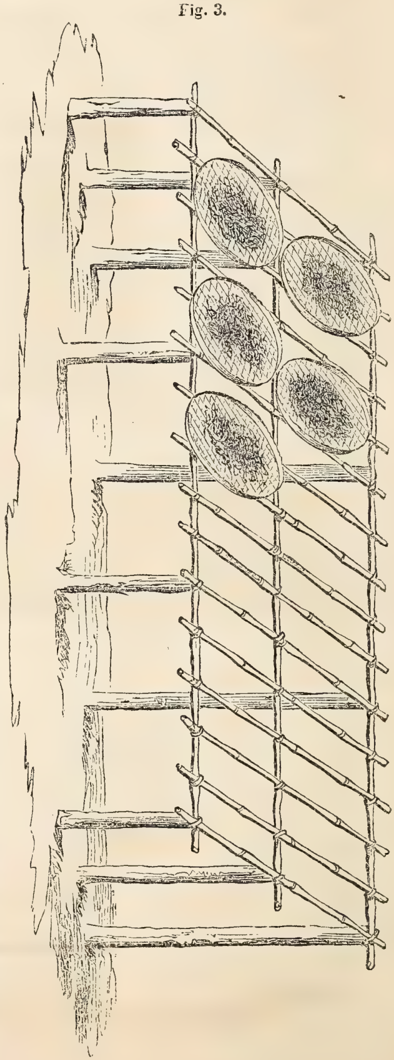
Fig. 2.



The leaves are then thinly scattered on shallow *open-work* bamboo trays, or baskets, called "*Challonees.*" (*Fig.* 2.) These are about three feet in diameter and two inches in depth. They are then placed on a light framework of bamboo (*Fig.* 3) and exposed to the sun and air for two or three hours, depending on the heat of the sun, or until somewhat soft and wilted. This effected, they are removed to the tea-house and placed on open shelves of bamboo, (*Fig.* 4, p. 457,) where they are allowed to remain about half an hour to cool, after which they are put into smaller "*Challonees,*" which are placed on tables, and the leaves "*beaten.*" This is performed by gently clapping the leaves between the hands, (*Fig.* 5,) tossing them up and letting them fall, for about five or ten minutes. They are then replaced on the shelves for half an hour, and again brought down and clapped as before. This is done three times in succession, which causes them to become soft and pliable, and of a brown color. During the operation of "*beating,*" the leaves give off a strong and peculiar aroma, at each time different, so that a person acquainted with it can tell at once whether it is the first, second, or third process the leaves are undergoing the moment he enters the tea-house.

Without this process of beating the tea, when made, would have a strong herby taste, and would not become sufficiently black. The leaves are now ready for the pan *(Korah)*.

Fig. 3.



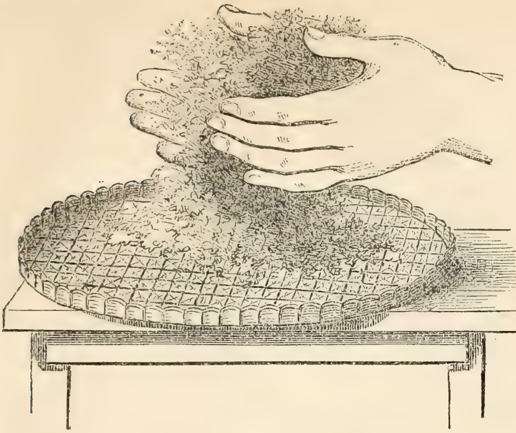


Fig. 5.

Fig. 6.

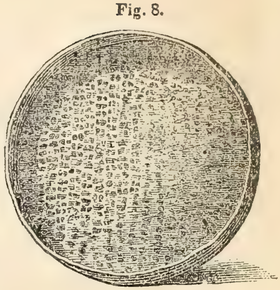


Fig. 8.

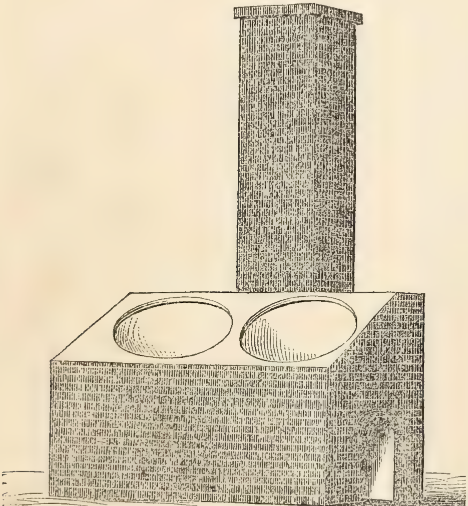


Fig. 7.

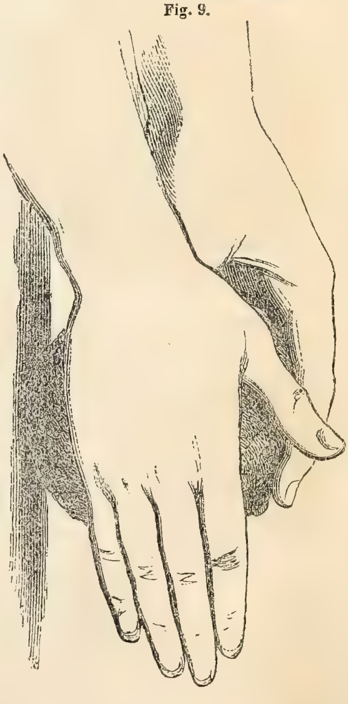


Fig. 9.

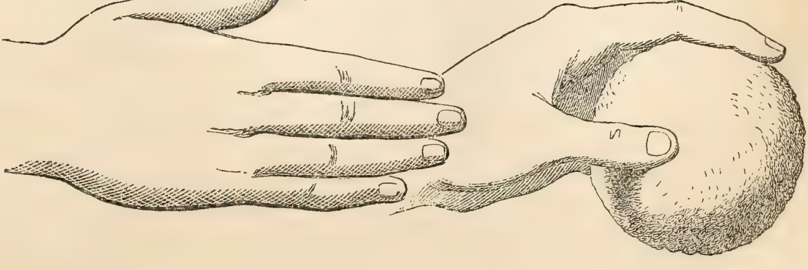
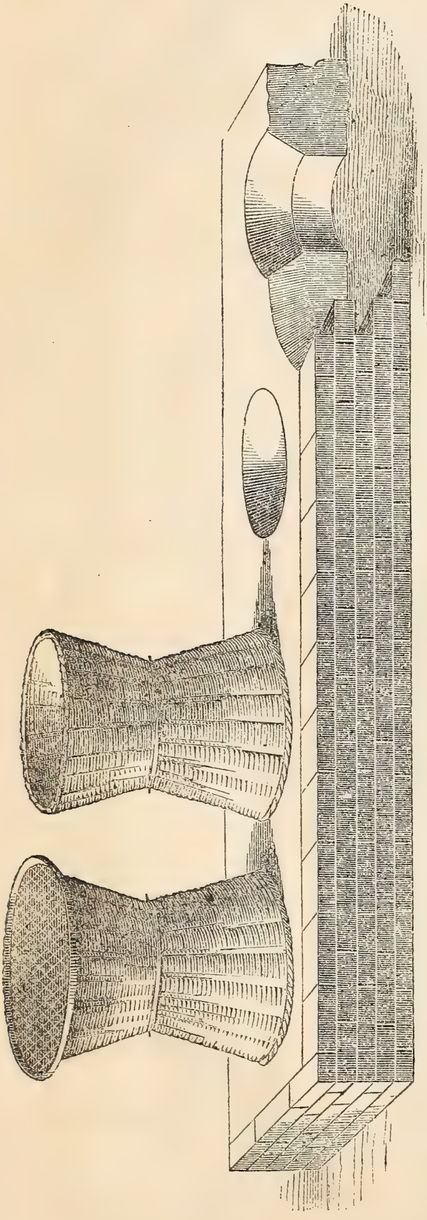


Fig. $9\frac{1}{2}$.

This is made of cast-iron, very thin, about two feet six inches in diameter, and six inches deep in the centre. (*Fig.* 6.) It is placed at an angle of about 30° in a brick fireplace, (*Fig.* 7,) three feet high at the front edge; it is well heated by a quick fire of light wood. About two pounds of the leaves are spread in the pan, where they make a cracking and fizzing noise like frying meat. They are rapidly turned with the *hands*, so as to prevent them from scorching. This process is called *Tatching*. As soon as the leaves become inconveniently hot, they are quickly brushed out on a *Dollah*, or close-worked bamboo tray, (*Fig.* 8,) which is held by a boy ready to receive them. A brisk fire is constantly kept up under the pan.

Fig. 10.



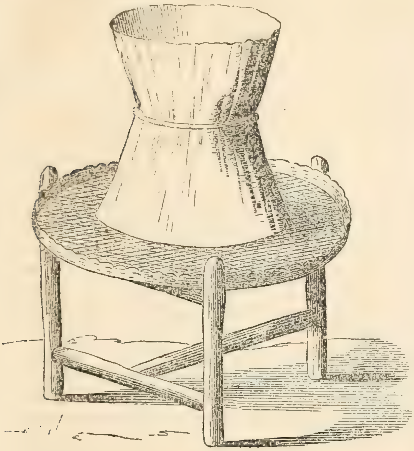
After using the pan in this manner three or four times, it becomes foul from the juice of the leaves sticking to it, rendering it necessary to scour it out with a soft brick and water.

The hot leaves are immediately given to men standing at a table, each with a *dollah* or tray before him, on which the leaves are rolled; this is done by collecting them into a ball, which is grasped by the left hand with the fingers close together, (*Figs.* 9, $9\frac{1}{2}$,) and the thumb extended, the hand resting on the little finger; the right hand extended in the same manner, but placed on the top of the ball. Both hands are employed to roll and propel the ball; the left hand keeping it in shape, and allowing it to revolve, and the right hand pushing it along with as much force as possible to express the juice from the leaves. The art lies in giving the ball a kind of circular motion, by pushing it in a curve towards the left, and causing it to revolve two or three times before the arms are extended to their full length, and then drawing it back quickly without leaving a leaf behind. It is rolled in this manner for about five minutes, occasionally opening the ball gently with the fingers, lifting it up and allowing it to fall, for the purpose of separating the leaves, which are again collected in the centre of the *dollah* by giving it a circular toss or shake.

The leaves are now returned to the pan to be "*tatched*" or heated, as before. The bare hand must always be used in the pan, to enable the operator to judge of the heat, or the leaves may be scorched. Again they are rolled as before, and should they not have sufficient twist, which may be known by a little practice, they must be tatched and rolled a third time. This being effected, they are placed in the "*Hûjjah*," or drying basket, (*Fig.* 10.) This is two feet six inches in height, and two feet in diameter at the top and bottom; one foot from the top the diameter is eighteen inches; at this place rests a small sieve of bamboo, on which the tea is put; the interior of the basket is lined with paper, the better to retain the heat. The leaves are thinly scattered on the sieve, not more than an inch or two in depth, and the whole placed over a charcoal fire, which must be very carefully regulated, so as not

to allow the least smoke.* The charcoal should be in small pieces, and the fire fanned until the whole gets well ignited, stirring it occasionally and bringing the coals to the centre, leaving the outer edge depressed. Great care must be taken that none of the leaves fall through the sieve into the fire, as the smoke will spoil the tea. A slap or two given to the basket before placing it over the fire will prevent this by causing the loose leaves to fall. The baskets are occasionally taken off the fire and placed on a large *dollah* or tray, *(Fig.* 11,) which is placed on a stand, *(Fig.* 12,) and the leaves turned over. After they become half dry and are still rather soft, they are taken off the fire and put on large trays, which are then placed on the shelves, *(Fig.* 4,) where they are allowed to remain several hours, or

Fig. 11.



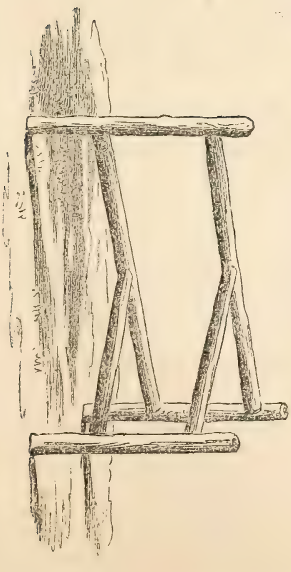


Fig. 12.

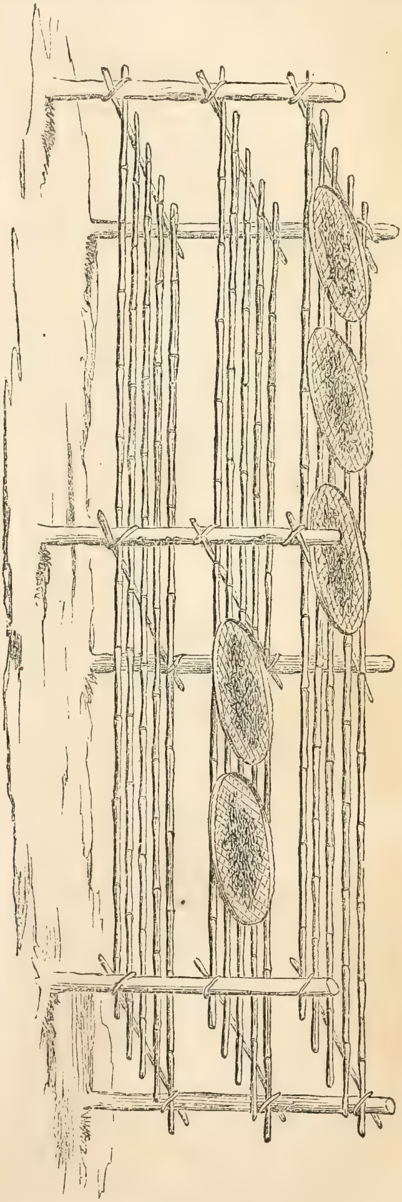


Fig. 4.

* There will be no smoke if the wood is perfectly charred.—T. G. C.

until next day, in order that the color of the tea may improve ; after this it is sorted into three or four different sizes, first, by passing it through neatly-made sieves of bamboo or brass wire, and then carefully picked over by men, women, and children. The smallest and youngest leaves are called *Pekoe*, the next *Souchong*, the next *Congo* or *Compoi*, and the largest *Bohea.* All the red and untwisted leaves are thrown aside as useless, or retained until the end of the season, to be worked over into inferior teas. After this separation it is very thinly scattered on the sieves in the drying baskets, keeping each kind separate. The baskets must be taken off frequently, placed on the large tray, and the leaves turned, care being taken, as before, that none of them fall in the fire. In fact, the tea should never be touched while it remains over the fire ; the basket must always be removed for this purpose. As soon as the tea becomes dry and crisp it is taken out and thrown into a large receiving basket, where it remains until the whole quantity on hand becomes alike dry and crisp. The fire must now be deadened by sprinkling ashes over it to make the heat more gentle. Large quantities of the tea are now put into the drying-basket to the depth of eight or ten inches, leaving a passage in the centre for the heat to ascend ; the leaves which have fallen through the sieve on the tray must be placed on the top of all, and the basket put over the fire with the greatest possible care ; a *dollah* being laid over it to retain the heat. The basket is lifted off from time to time, placed on the tray, and the hands, with the fingers apart, run down the sides to the sieve, and the tea gently turned over, the passage again made in the centre, and the basket replaced over the fire. When the leaves become quite crisp, so that they break easily with the slightest pressure of the fingers, the tea is finished and ready for packing.

The process of drying is technically termed "*firing*," and the more gentle the fire and the longer the tea remains over it the better, as by this means the *herby* taste is removed. It is best to pack the tea while warm, taking care also that the box is perfectly dry. It is usual to weigh it out in small quantities and to press it into the box firmly with the hands and feet until it becomes full.

The above is a full account of the method of manufacturing the usual kinds of Black tea, as practiced by the Chinese Tea-makers in Upper Assam. But very little of it ever finds its way to market in the same state that it leaves the factories. The tea dealers usually open the boxes, break the tea through sieves, mix different qualities together, &c., &c., and classify and rename the whole to suit the market.

It is named in the first place from the size and age of the leaf. The small unopened bud or leaf *a (Fig.* 1.) is covered with a very fine whitish down, and does not turn Black by the process of manufacturing, but, if anything, becomes more white. This leaf and the one next to it, *b*, which is not quite fully expanded, constitutes what is called "*Flowery Pekoe*," (Chinese *Thoung Pâho.*) By the addition of the next leaf *c*, the tea receives the name of "*Pekoe (Twazee Pâho,)*" the small white leaf not being in as great proportion as before. The leaf *d* is named *Souchong*, but with this there may be portions of some of the other leaves. *Pouchong*, *Congo*, and *Compoi* are made from the leaf *e ; Toychong* and *Bohea* from the largest leaf of all, *f*. These are again divided into classes. So much depends, however, on the appearance of the tea and other causes, that it is impossible to give any general rule by which to name it.

The flowers of the *Olea fragrans* or sweet-scented Olive (Chinese name, *Quifa*) are sometimes added to the Black teas, particularly those that are damaged, to give them a fragrance.

It is usual to gather the leaves from one to four times during the season, according to the age and size of the tree. The leaves of the first *crop*, termed by the Chinese *Show chun*, or "first spring," are more delicate and of a finer quality than those of the succeeding crops, although the produce is much smaller. The second crop, *Urh chun*, or "second spring," commences in May when the branches are covered with leaves, but they are rather coarser, and not quite so bright a green as in the first crop. The third crop, *San chun*, or "third spring," commences about the middle of July, leaves the same as those of the second crop. A fourth crop should not be taken, as the leaves become old and coarse, and are only fit for the most common kinds of tea. The plant is also injured by plucking it too close before the cold weather sets in.

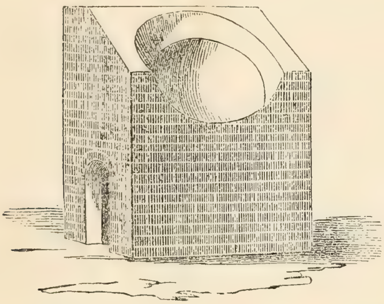
When the leaves are abundant each person can pluck about sixteen pounds per day, but when they are scarce he may not succeed in collecting more than eight or ten pounds. In dry weather about four pounds of green leaves will make one pound of tea, but in wet weather it requires six or seven pounds, owing to the quantity of moisture collected with the leaves. Plucking cannot be delayed on account of rainy weather, or anything else, for should the leaves be allowed to remain a day or two after they are of a proper size, so rapid is their growth, they would become too old for making a fine quality of tea.

The produce of each plant varies very much, but we may take the average for plants three years of age at one and a half ounces, and the number of trees on one acre of ground at 2,000—this would give 187 pounds of tea ; plants four years old, two and a half ounces, equal to 312 pounds per acre ; the fifth year, four ounces, equal to 500 pounds ; and the sixth year, six ounces, equal to 750 pounds to the acre. The trees are now in full bearing

order, and cannot be expected to produce a much larger average quantity, although I have known a particularly luxuriant plant to give as much as eight ounces of tea. Much depends on good cultivation.

Some kinds of tea cannot be made on a rainy day, for instance, the *Pouchong* and *Mingehew*. The leaves for these should be collected on a sunny morning after the dew has evaporated. The *Pouchong* is only made from the leaves of the first crop, but the *Mingehew* can be made from any crop. In China the "*Song-sûn-chah*," or upland teas, consist of *Minchong* and *Pouchong*, the first of which is used on occasions of ceremony by the emperor and great dignitaries of the empire, and not a leaf of either description is ever exported. The *Sychee* tea is also considered of a very superior quality, and is used as offerings to the priests, or kept for festivals. It is thus made: the leaves are the *Souchong* and *Pouchong*, *d* and *e*. After they have been gathered and dried in the sun, in the same manner as the other black teas, they are beaten and put away four different times. They are then pressed into baskets and covered with a cloth. When they become heated and give out a peculiar smell they are ready for the pan. This pan (Fig. 13) is fixed in masonry, at an angle of 40°, with the walls raised around the back and sides of the pan, the bottom of which is made *red hot*. The operator covers his mouth and nostrils to prevent him inhaling any of the hot vapor. A man stands to the left of him with a basket of prepared leaves, and another to the right with a *dollah*. At a signal given by the operator the man with the leaves dashes a handful quickly into the red hot pan, where they are tossed and turned rapidly for about half a minute, then quickly brushed out on the *dollah*, which is held ready to receive them. The man that holds the *dollah* keeps lifting up the leaves and letting them fall with the disengaged hand, so that they may cool rapidly, while the man with the leaves instantly dashes into the pan another handful, and the process goes on as before.

Fig. 13.



It must all be done with the utmost rapidity, and should a leaf be left in the pan accidentally, it must be brushed out quickly, before another handful of the leaves is thrown in, or the smoke will ruin the tea. A strong fire must also be kept up under the pan, as the rapid succession of fresh leaves tends greatly to cool it. As soon as the *dollah* has received about four handfuls of the hot leaves from the pan, it is removed and another *dollah* held ready, and so on until all is finished; after which the pan must be cooled and scoured out. It is then ready for another basket of leaves.

The leaves are now rolled and *tatched* in the same manner as the other teas, and put into the drying basket for about ten minutes. When a little dry, the leaves are worked and pressed in the hands in small quantities, say about half to three-quarters of an ounce at a time, for about half a minute; they are then folded up in small square pieces of paper, and placed in the drying basket, where they are permitted to dry slowly for several hours, or until perfectly dry.

This tea is very difficult to make, and requires great dexterity in the manipulator. *Pouchong* tea is made in the same way, with the exception of making it into balls.

The *Mingehew* tea is made from the *Pouchong* leaves, *e*. They are dried in the sun, and beaten and put away three times, as in the other teas. About two pounds of the leaves are then divided into four parts and placed on a small *dollah;* on the top of this is put another *dollah*, with the leaves divided in the same manner, and so on, piling the *dollahs* one on another until all is finished. The *red hot* pan is used, as in making *Sychee* tea. The man with the leaves casts one division into the pan at a time, and this is tossed about rapidly for about half a minute, and then swept out. The next division is cast in, in like manner, the contents of each *dollah* being kept separate. They are then placed on shelves to air, after which the leaves are *tatched* and rolled, in the same manner as the other black teas. Each division is now placed on sheets of paper, and *fired* in the drying basket. When it is half-dried it is put away for the night, and the next morning it is picked and put into the drying baskets over slow fires, and gradually dried. It is then packed hot.

"*Shung Pâho.*"—Pluck the young *(Pâho)* leaf that is not blown or expanded, and has the down upon it, and the next one that has blown, with a part of the stalk; put it in the pan for half an hour; then into the shade; *tatch* over a gentle fire, and in *tatching* roll the leaves occasionally in the pan, and spread them around its sides; again roll them until they begin to have a withered and soft appearance; then spread them on large sieves, and put them in the shade to air for the night. Next morning pick and fire them well. This tea

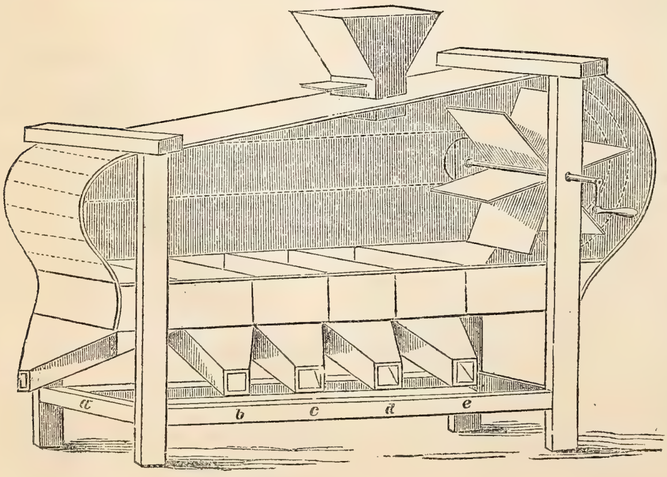
is not good, although it is valued in China on account of its scarcity and high price, as many inferior articles are in this country. Teas made from more mature leaves are much to be preferred.

Manufacture of Green teas.—Each leaf is plucked separately (without any of the stalks) as high as the *Souchong* leaf, *d*, (Fig. 1.) The next leaves, *e* and *f*, are not used for green tea, unless they appear to be quite young and tender. From two to three pounds are cast into the pan as soon as they are brought in; they are tossed about until they become too hot for the hands. Two slips of bamboo, each about a foot long, split at one end so as to form five or six prongs like a fork, are now used to tumble and toss the leaves about, by running the sticks down the sides of the pan and turning them up, first with one hand and then with the other, as fast as possible, to prevent them from burning. This lasts from two to three minutes; the leaves will then admit of being rolled without breaking. The leaves are then rolled for about three minutes, in the same manner as the black teas, by which a quantity of the juice is extracted. They are then pressed hard with both hands, to express as much juice as possible, and to form them into balls. These balls are now put on *dollahs*, which are then placed on the frame, (Fig. 3,) where they are exposed to the sun for two or three minutes, after which they are opened, and the leaves scattered thinly on the *dollah*. When the leaves have become a little dry, which will be the case in from five to ten minutes, if the sun is hot, they are again rolled, pressed, and placed in the sun as before; this is done three times in succession. In rainy weather this drying is done over a fire in a drying basket; but drying in the sun is much to be preferred, when practicable. The leaves are now put in the hot pan and turned about until well heated, and then brushed out into a basket, and, while hot, put into a very strong bag, generally made of stout cotton drilling, and about three feet long and one foot wide. Into this bag the leaves are pressed with the hands and feet with as much force as possible, from fifteen to twenty pounds being put in at one time.

The mouth of the bag is now closed and grasped firmly with the left hand immediately above the leaves, whilst with the right hand it is beaten and pummelled, turning it occasionally and twisting its mouth. This is continued for some minutes, until the leaves are forced into as small a space as possible in the end of the bag. It is now made fast by twisting it close to the leaves, and then the bag is doubled by drawing the mouth of it over the ball of leaves. The operative then places the ball under his feet, and holding on by a post or cross-bar, he presses with all his weight on the ball, stamping on it with both feet, at the same time rolling it over and over, and occasionally opening the bag to tighten it more firmly. This he continues until the ball is almost as hard as a stone. The mouth is then well secured, and the bag put away until next day. It is then opened out, and the leaves gently separated and placed on *dollahs*. They are then put in the drying baskets and "fired," until they become quite dry and crisp, the same as the black teas.

The tea is now half finished, and may be packed in boxes and put aside, if necessary, until the close of the season, or time is found to put it through the second process. The boxes are then opened and the tea is exposed on large *dollahs* until it becomes damp and sufficiently soft to roll without breaking.

Fig. 14.



The same description of pan is now used as that for *Sychee* black tea (Fig. 13.) The pan is made very hot, but not red, and from six to seven pounds of the tea is thrown in, and rubbed with some force against the pan with the palm of the hand, giving the arm a good sweep, so as to throw the tea up against the back and sides of the pan, causing it to tumble back

over the hand. This process is continued for about an hour. The tea then has a pale greenish color, and appears quite glossy. It is now taken from the pan and passed through sieves of three different sizes.

A winnowing machine is then used, (Fig. 14,) with movable divisions, which separate the interior into four or five troughs. The tea is placed in the hopper above, and the handle is turned with the right hand, while with the left the quantity of tea is regulated that shall fall through the hopper, by drawing a slide at the bottom of it. The blast from the fan blows the dust and smaller particles of tea to the end of the machine, where it is intercepted by a board, and falls through an opening, *a*, at the bottom into a basket placed to receive it. The next lightest tea is not blown quite as far, and falls out through the trough *b*, on the side. This tea is called *Young Hyson.* The next, being a little heavier, falls out at the next trough, *c*, and is called *Hyson.* The next, which is still heavier, falls through the trough *d;* it is in small balls, and is called *Gunpowder* tea. The heaviest falls out at the trough *e*, close to the fan ; it is much larger than Gunpowder tea, and is composed of several small leaves, which adhere firmly together ; it is called *Big Gunpowder.*

This last kind is generally put in a box and chopped up with a sharp instrument; it is then sifted and mixed with the Gunpowder tea, which it now resembles. The different sorts of tea are then put on *dollahs*, and men, women, and children are employed to pick out the sticks and bad leaves. Neatly made bamboo or brass-wire sieves of different sizes are also used to assist in removing the sticks, &c. After the tea has been well-sifted and picked, it is put into the hot pan and rubbed as before for about an hour ; it is then put on *dollahs*, and once more examined to separate the different teas that may still remain intermixed. The Chinese now use a mixture of indigo and sulphate of lime, in the proportion of one part of the former to three of the latter, very finely pulverized and sifted through fine muslin ; about half a teaspoonful of the mixture is added to a pan containing from six to seven pounds of tea, which is again rubbed as before for an hour.

The process is then finished, and the tea is packed hot in the boxes, pressing it down firmly with the hands and feet.

The above mixture is merely used to give the tea a uniform color and appearance ; it does not affect the flavor. The indigo called by the Chinese *Youngtin* gives the color, and the sulphate of lime, *Acco*, fixes it. I have repeatedly made very excellent green tea without using either of the above ingredients ; but the color was not so good; some of the leaves, being much lighter than the others, gave the tea the appearance of being mixed.

Big Gunpowder tea is called by the Chinese, *Tychen ;* Little Gunpowder, *Cheocheu ;* Hyson, *Chingchah ;* Young Hyson, *Uchin ;* Skin-tea or old leaves in small bits, *Poochah;* the fine dust or Powder-tea, *Chahmoot.*

As some of the leaves which answer very well for the Black teas are rather too old for the Green teas, it is advisable to have them plucked at the same time by the same person, and when brought to the tea-house they may be separated by passing them through coarse sieves.

I have tried the plan of having them plucked into separate baskets, but the plucker was almost sure to mix them by mistake, or else get on so slowly with his work that we found the plan of sifting much to be preferred.

In making the Black teas alone it is much better to separate different sized leaves as much as possible, by passing through coarse sieves of different sizes before manufacture, as the young leaves do not require so much *tatching* or rolling as those of a larger size ; and the juice of the latter, mixing with the young leaves, is liable to injure their finer qualities by giving them a harsh flavor resembling the coarse teas.

The Singphoes, a tribe of people inhabiting a hilly district of country between Assam and Birmah, have a method of their own of manufacturing tea. The young and tender leaves are first plucked and dried a little in the sun ; sometimes they are exposed to the heat of the sun and the night dews, alternately, for three successive days ; another way is, that, after drying them a little in the sun, they are put into hot pans and turned about until quite heated. This effected, they are put into the hollow of a bamboo in small quantities at a time, and firmly driven down with a stick, at the same time turning the bamboo in the smoke of a fire. Thus prepared the tea will keep good for several years. When removed from the bamboo, it appears in long, round, black sticks, with a strong smell not unlike tobacco. The mass is so hard that it is necessary to cut it with a knife into small chips before making an infusion. It is not very palatable, but it may be used when better is not to be procured.

Tea is the favorite beverage of the Kumties, another of the border tribes. Their mode of manufacturing is not very refined. The tea is generally prepared in balls about the size of an eighteen-pound shot, and is hard as a brick. In this state it keeps good a long time.

Further East there is another method of manufacture. Holes are dug in the earth, and the sides lined with large leaves. The green leaves of the tea plant are then boiled, the

decoction thrown away, and the leaves put into the hole and covered with other large leaves and earth. This is done with a view of reducing the leaves to a state of fermentation; after which they are put into hollow bamboos, and thus prepared are taken to market. When intended for use the leaves are boiled and the infusion drank.

The Bootias, a tribe of people inhabiting the lower range of the Himalaya Mountains between Assam and Thibet, are particularly attached to tea as a beverage. Their supplies are, however, imported from Pekin by a land journey of eight months' duration. Captain Turner* gives the following account of a tea-drinking with the Rajah of Bootan.

"Three small benches, similar to that before the Rajah, were brought and placed before us; and presently a servant came, bearing a large tea-pot of white metal, embossed, and highly ornamented with some other metal of yellow color. He approached the Rajah, and then giving a circular turn to the tea-pot so as to agitate and mix its contents, he poured a quantity into the palm of his hand, which he had contracted to form as deep a concave as possible, and hastily sipped it up. To account for a custom which has so little either of grace or delicacy in its observance, however recommended by extensive fashion, we are obliged to have recourse to the suspicions suggested in remoter times by the frequent and treacherous use of poison.

"However humble or exalted the rank of the person who introduces to his guests the refreshment of tea, the cup-bearer, which is an office of the first credit, never presumes to offer it without previously drinking some of the liquor that he brings.

"The Rajah held out, upon the points of the fingers of his right hand, a shallow lacquered cup of small circumference, which was filled with tea. Three cups had been sent, and were set down before us. The Rajah directed his servant to fill them also, still holding the cup in his right hand; he repeated in a low hollow tone of voice a long invocation, and afterwards dipping the point of his finger three times into the cup, he threw as many drops on the floor by way of oblation, and then began to sip his tea. Taking this as a signal, we followed the example, and partook of the dishes of parched rice that were served up with it. We found this liquor extremely unlike what we had been accustomed to drink under the same name; it was a compound of water, flour, butter, salt, and Bohea tea, with some other astringent ingredients, all boiled, beat up, and intimately blended together. I confess the mixture was by no means to my taste, and we had hitherto shunned as much as possible these unpalatable libations, yet we now deemed it necessary to submit to some constraint; and having, at last, with tolerable grace swallowed the tea, we yet found ourselves very deficient in the conclusion of the ceremony. The Rajah, with surprising dexterity, turned the cup as he held it fast betwixt his fingers, and in an instant passed his tongue over every part of it, so that it was sufficiently cleansed to be wrapped in a piece of scarlet silk, which bore evident marks of having been not very recently devoted to this service. The officers who had entered with us were not permitted to partake of this repast, and, but for the honor of it, we would willingly have declined so flattering a distinction."

It appears, however, that this *tea-soup* is not so disagreeable to the taste after using it a few times, for in another place this author states: "We had also dried fruits, consisting of dates and apricots. Buttered tea was not omitted in this repast; nor, indeed, was it the least acceptable part of it, for habit had not only rendered this composition agreeable to our tastes, but experience most fully proved that warm liquids, at all times, contribute to alleviate the sensation of fatigue. I was never more disposed to praise the comfortable practice of the country, having constantly observed that the first object of attention with every man, at the end of a long journey, is to procure himself a dish of hot tea. If you are expected, it is always prepared and brought to you the moment you arrive."—*Turner's Embassy*, *p.* 195.

As the Chinese method of making sheet-lead for lining tea boxes may prove interesting, I give an account of it here: Two perfectly flat tiles are required, earthen or stone, each about an inch and a half thick, and sixteen inches square. On one side of each is pasted a sheet of very smooth and thick paper, and on this, at the edge, is pasted a narrow strip of the same kind of paper, making a slight elevation equal to the thickness of the sheet of lead to be made. Very fine chalk is rubbed over the surface to prevent the lead from sticking to or burning the paper. In the corner of the room there is a fire-place, over which is placed an iron pot or one of the pans used in making tea, in which about twenty pounds of a composition consisting of eight parts (by weight) of lead and one part of tin is put and melted. Two iron ladles are used, one having a long handle, and with holes in the bottom, for the purpose of removing the dross from the lead, and the other with a short handle for taking the lead from the pan when required. The tiles are placed at a convenient distance from the melted lead, the lower one resting on a block of wood about four inches in thickness, and of the length and breadth of the tile; the upper tile is placed

* Turner's Embassy to the Court of the Teshoo-Lama in Thibet, p. 69.

upon the lower one perfectly even at the sides, but projecting a little backward towards the operator, who squats down on them with his heels near the edge, and his toes near the centre. With the left hand the front edge of the tile is raised about three inches, assisting the operation by pressing with the heels and gently lifting the toes. About half a ladle full of the melted lead is now poured in, resting the ladle on the front edge of the lower tile; then letting go with the left hand and pressing with the feet, the upper tile is brought down with some force, causing the superfluous metal to gush out at the sides. The upper tile is then raised as before, like the lid of a box, and a fine thin sheet of lead, nearly the size of the tile, is taken out and laid aside, making about four sheets of lead in a minute. Many interruptions take place, such as examining the tiles, changing their position, rubbing the paper with chalk, &c. The sheets of lead must also be examined occasionally by holding them up to the light; for, if not properly made, they sometimes have a number of very fine holes in them, which are not perceptible when lying on the ground or table. On this account about twenty of the sheets first made are thrown back into the pan without examination; for, until the tiles become tolerably warm, the sheets will be more or less imperfect. The operator sometimes stands up, and, with one foot on the upper tile, manages to work it with his heel and toes about as rapidly as in the sitting position; but as the latter is the most natural position for a Chinaman, he always prefers it. At the front and sides of the tiles are placed pieces of bamboo, covered with paper, to receive the lead that is pressed out, and prevent it coming in contact with the ground.

For making the tops of the canisters, which are generally of tin only, but which may be made of the above composition, two larger tiles are used, as it is usual to make the lids in one piece.

For forming the canister it is necessary to have a pattern-box made to fit easily in the tea-box. The bottom of this box has a hole in it for the escape of the air in putting it in or withdrawing it from the canister, and, instead of a lid, a bar of wood is fastened across the top for a handle. This box is turned upside down, and the canister made over it; when ready, with the exception of the top, it is placed in the tea-box and the pattern withdrawn. The top of the canister can be attached afterwards.

For soldering one part of quicksilver to ten or twelve parts of tin is used. In the centre of a stone, six or eight inches square, there is a small hollow, into which the solder, with a small portion of rosin, is put; it is melted by rubbing the hot soldering-iron on it. As soon as the iron is sufficiently cool to allow the solder to hang in drops to it, it is lifted gently and applied along the seams of the sheet lead, over which a little rosin has previously been rubbed. This is an excellent method for soldering thin sheets of lead; for, should the iron be too hot, the solder will not adhere to it, and the danger of melting the lead at the seams is thereby obviated.

The Assam tea is at present packed in sheet lead sent from England. It is made by machinery, and is much better and cheaper than that made by the Chinese.

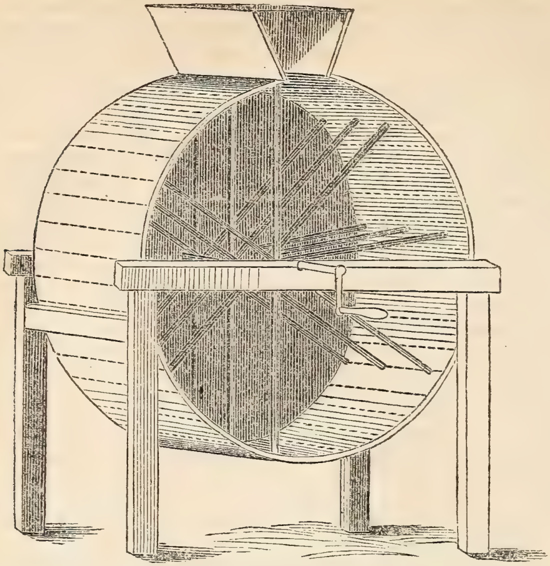
The tea boxes are covered with paper pasted on and dried in the sun; they are then rubbed over with a mixture of paste and pulverized turmeric to give them a yellow color and as a sizing to the paper. The paper on the corners of the box is ornamented by means of a wooden block on which is carved the figure or flowers used. On this block very thin paper cut to the proper size is laid, and a mixture consisting of pulverized turmeric, indigo, and water having a dark green color, is rubbed over the surface of the paper (not the block) with a stiff brush made of the fibres from the cocoa-nut husk. The slips of paper are put on one above the other twenty thick or as long as the paper shows the impression of the carved wood below. When the corners of the boxes have been ornamented with this paper and dried, another mixture about the proportion of two quarts of drying oil to three pounds of rosin boiled together, is applied with a cocoa-nut brush over all the boxes as a finish.

I now wish to say a few words with reference to the possibility of cultivating and manufacturing tea in the United States, so as to compete successfully with the imported article. I think it can be done.

It may be supposed that the cost of manufacturing would be too great. This, without doubt, can be done almost entirely by machinery. *Fig.* 15 represents a machine which I had made for "*beating*" the leaves in the process of making Black tea. This answered the purpose quite as well as beating with the hands; one man or boy could do as much work with it as ten men could do by the old method. "*Tatching* and *firing*" or drying, I am satisfied, although I had no means of testing it, can be done much better by steam than by the Chinese mode. Hollow tables might be arranged with the pans inserted, perfectly steam tight. These may be heated to any required degree of temperature, by allowing the steam to pass through the tables under pressure. There could be no possible danger of burning the tea, as the heat could be regulated to a nicety with thermometers, which is a very difficult matter when depending on the uncertain heat of a wood fire; sometimes the pan becomes too cold, at others too hot; and a single handful of leaves burnt or scorched will ruin the entire batch of tea. Other tables might be

arranged with deep cavities for drying the tea, and as this must be done at a much lower temperature than that required for the pans, the same steam might be used after it leaves them.

Fig. 15.

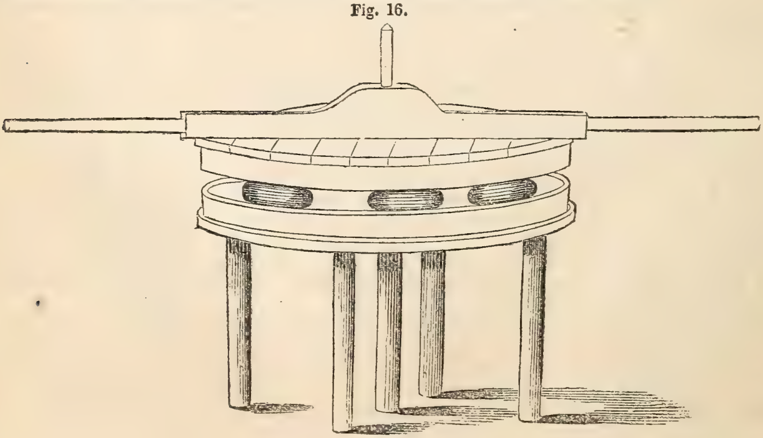


For rolling the leaves, I am not confident that any plan I can recommend will answer the purpose. I have experimented considerably, and succeeded in making a machine that would answer to some extent, but I could not succeed in giving the leaves the proper spiral twist, and at the same time express the juice, without breaking them too much. Some of our American inventors would soon find a remedy for this difficulty after seeing the Chinese method of rolling the leaves.

Separating the different kinds of teas can be done to a great extent by having sets of sieves arranged over each other, and worked by machinery. Very little sorting over by hand would then be required, merely for the purpose of removing all unsightly and coarse leaves that had not been sufficiently rolled.

Another machine *(Fig. 16)* was introduced by Mr. Robert Strong, one of the assistants, for the purpose of rolling green tea after it had been put in the bags. This answered the purpose admirably. Two men could do more work with it and better than ten men could by the old method of rolling with the feet, as a dozen or more bags could be placed in it at a time, and by putting weights on the top any desirable pressure could be given. With a little attention this machine might be made to work with a crank at the side.

Fig. 16.



The process of making green tea, rubbing it in a hot pan for three hours, is very fatiguing, and any one standing beside a fat half dressed Chinaman, (the thermometer at 90°,) watching his exertions and seeing the streams of perspiration trickling from his arms and face into the tea-pan, might think it advisable to invent some machine as a substitute. It may alter the peculiar flavor of the tea, and perhaps it may not have the effect usually ascribed to it, that of banishing sleep.

Plucking the leaves must always be done by hand, as no machine that can be invented can discriminate between old and young leaves.

I would particularly recommend the speedy introduction into this country of the Assam variety of the tea plant. It produces many more pounds of tea to an acre of ground, and from little more than half the number of trees per acre than the Chinese variety. The tea is also of a higher flavor, and therefore more economical for domestic use. In one of the *Barries* under my charge, *(Tippum,)* the place at which I resided, and therefore had better opportunities of thoroughly testing the comparative value of the two varieties, we had a patch of ten thousand Chinese tea plants, occupying about three acres of ground. Notwithstanding every possible care and attention, they would not produce as much tea as one thousand of the Assam plants, occupying not more than half an acre of ground. They, however, bore a prodigious quantity of seeds, but as it was not considered advisable to extend the cultivation of the plant, I had the greater part of the flowers pulled off early in the season, hoping by that means to increase the number of leaves. It was all to no purpose; the plants were not worth the ground they occupied, when compared with the indigenous plant It is probable that the Chinese variety having been cultivated in China for many centuries, and, as it is said, from time immemorial, and on the same hills, constantly plucking the leaves has become stunted or dwarfed, for it very rarely grows over three or four feet in height, while the Assam plant has to be topped every season to prevent its getting out of reach of the pluckers.

The plants of either variety may be raised in nurseries from the seed or from slips, planted in rows about six inches apart each way. The beds should be about four feet wide, that all parts may be within reach of the hand for the convenience of weeding. It is much better, when it can be done, to plant them at once where they are intended to remain. The seeds should be put, three or four together, in holes about two inches deep; the rows for the Assam plant about five feet apart, and the plants at the distance of four feet from each other in the rows. This will give, after allowing for vacancies, spaces occupied by trees, &c., about 2,000 plants, or rather bushes, to an acre of ground. They had better be placed in the position shown in the diagram. This will give them more room to expand their branches than by planting them precisely opposite each other.

The Chinese plants may be put in rows four feet apart, and the plants at the distance of three feet in the rows. This will give about 3,600 plants to an acre.

The most suitable place for forming a tea plantation would be a rough, hilly piece of ground, with a Southern exposure, and intersected by streams of water. A few forest trees should be left standing upon it, as a full exposure to the hot, glaring sun for the entire day during a very dry season is injurious to the plants.

In forming plantations on level or slightly undulating ground the earth should be raised into ridges, about eight or ten inches high, on which the plants should be placed. The Chinese sometimes plant as many seeds in each hole as can be held in the double hand; ten or fifteen of these usually vegetate, and are allowed to remain so as to form a thick bush. They very seldom transplant, and when they do they place six or eight of the plants together. This is not a good plan, as they are apt to impede each other's growth; three or four together answer the purpose much better. The seeds vegetate and the plants make their appearance above ground in from two and a half to three months after planting, depending on the weather.

It would be a very easy matter for a small family, having a suitable soil and climate, to cultivate and manufacture all the tea they require for their own use, and perhaps have some to spare. A patch of ground fifty feet square, having upon it, say 120 trees, should produce the third year about 11 pounds, increasing until the sixth year, when the quantity should be about 45 pounds, of good wholesome black tea; and all this with comparatively little labor or expense: a tea pan, a few baskets and trays, a table, &c., not costing five dollars altogether, and lasting many years.

They might not, perhaps, without considerable practice, be able to make the tea *secundum artem*, but it would have the merit, at all events, of being a pure article, which is more than can be said of a great deal of the stuff now sold under the name of tea. I have frequently examined specimens of cheap teas in this country, and in some of them, after the closest scrutiny, I could not detect a single genuine tea leaf. I do not pretend to say that all, or

even a majority, of the cheap teas are spurious, on the contrary, many of them are of excellent quality; but it requires a practical knowledge of the business to distinguish between true and false teas. The adulteration of tea is carried on to a far greater extent in England than has ever been attempted in this country.

A work entitled "The Commercial Hand-Book of Chemical Analysis," published in London, is full of curious information. With regard to green teas, it is stated as a positive fact, that the bloom is most extensively given in the warehouses of British merchants, by means of magnesia and Prussian blue. The seemingly unbroken appearance of the sheet of metal, in which the tea is tightly packed in the chest, is no criterion of its genuineness. Through the hole which is made in the metallic sheet for the purpose of taking a sample, the whole of its contents are emptied on a clean floor, and the tea is then mixed with any composition it may be thought fit to add, or *worked up* with teas of an inferior quality, or with those which by themselves are unsaleable. The repacking is done by re-introducing the tea by small portions at a time, and the workman from time to time carefully puts his foot through the opening which was made for taking the sample, and through which the tea was emptied; then grasping a rope fixed against the wall in order to steady himself and keep his balance without danger of enlarging the hole, he heavily treads the tea down by a series of jerks until at last a quantity of tea equal in weight to that at first emptied, is thus pressed into the same bulk or space as before, so that the chest has all the appearance of a genuine importation.

It is stated that black tea is also mixed, sometimes with pulverized extract of logwood, and sometimes with black lead, which gives it a shining and lustrous appearance. The former is easily detected by moistening a small portion of the tea leaves of the sample with water, and rubbing it gently about on a sheet of white paper, which, in that case, will be stained a bluish black; moreover, if a portion of the tea, being thrown into cold water, imparts immediately to the liquid a pinkish or purplish color, which is rendered red by the addition of a few drops of sulphuric acid, it is a sign of the presence of logwood; for genuine black tea produces only after a time a golden brown liquor, which is not reddened by sulphuric acid. This addition of logwood to black tea is for the purpose of simulating strength by the high color of the infusion, something like the addition of chicory to coffee.

Tea is also sometimes adulterated by an admixture of sloe or elder leaves, the only mode of detecting which is by a careful examination of the leaves after they have been untwisted by infusion or moisture; tea leaves have a different structure—they are more elongated, the edges are more deeply serrated and more delicate than those of the above named plants.

Lastly, tea is sometimes adulterated by an admixture of tea leaves which have been already used, and which are dried again and twisted in imitation of the state in which they were originally. This kind of fraud can hardly be detected in any other way than by the want of flavor of the infusion which such tea yields.

There are a few other important matters in connexion with the manufacture of tea, such as the Chinese mode of changing black tea into green, or green tea into black, restoring musty or damaged tea to its original appearance and flavor, &c., &c. But as my article is already too long it may be as well to conclude here.

Explanation of the Drawings.

Fig. 1. A shoot of the tea-plant, showing the leaves used in making tea.

Black Teas.	*Green Teas.*
a, b. Flowery Pekoe, (Thoung Pâho) Shung Pâho.	
a, b, c. Pekoe, (Twazee Pâho.)	Imperial, Big and Little Gunpowder. Hyson.
d. Souchong, Minchong, Sychee.	Hyson, Young Hyson, Twankay.
e. Pouchong, Congo, Compoi.	Young Hyson, Twankay, Hyson Skin.
f. Toychong, Bohea.	Hyson Skin and Dust.

The above classification is tolerably correct as regards the Black Teas, but the Green Teas are generally composed of parts of all the leaves mixed together, in various proportions. The name depends entirely on the appearance, size, and flavor of the tea after manufacture.

Fig. 2. Challonee, or open-work tray, from 2 feet 6 inches to 3 feet in diameter, with a rim 1½ inch deep; principally used for the green leaves.

Fig. 3. A rough frame, about 3 feet in height at the front edge, placed in a situation exposed to the sun for the purpose of withering or softening the green leaves.

Fig. 4. A light frame, having three or more shelves, placed along the wall inside the tea-house for holding the Challonees with leaves after they have been removed from the sun, &c.

Fig. 5. Shows the manner of "beating" the leaves with the hands.

Fig. 6. Cast-iron tea-pan, 2 feet 6 inches in diameter, 6 inches deep, and about a quarter of an inch in thickness.

Fig. 7. Two tea-pans, placed at an angle of 30 degrees in a brick fire-place, 3 feet high at the front. There is a partition, in the interior, between the pans, separating it into two parts, each having a communication with the chimney.

Fig. 8. Dollah, or close-worked tray, from 2 feet 6 inches to 3 feet in diameter, with a rim 1½ inch deep; used for rolling the leaves upon, and various other purposes.

Fig. 9. Shows the method of rolling the leaves; the left hand grasping the ball of leaves, and the right extended, ready to be placed upon it.

Fig. 10. Hâjjas, or Drying-baskets. These are represented as they are placed when in use, one of them covered with a dollah. The charcoal fire is made in holes called "Choolas," they are about 18 inches in diameter and one foot deep, made, as represented, at the side. The hâjjas are 2 feet 6 inches in height, and 2 feet in diameter at the top and bottom; one foot from the top the diameter is 18 inches; at this place rests a small "challonee," or sieve, on which the tea is put. The interior of the basket is lined with paper to cause it to retain the heat. These baskets are generally ranged along the walls of the tea-house, and over them are shelves similar to fig. 4, for placing dollahs, &c.

Fig. 11. Drying-basket, standing on a large dollah, which is placed on a stand, represented by fig. 12.

Fig. 13. Pan for *Sychee* and Green teas, placed at an angle of 40 degrees with the walls built up at the back and sides of the pan to the height of 8 or 10 inches. A pair of these pans may be placed at the back of the Black tea-pans, using the same chimney.

Fig. 14. Winnowing machine for Green teas, represented with the side removed, showing the interior arrangement.

Fig. 15. Beating machine, represented with the front removed, showing the interior; diameter 4 feet, breadth 2 feet.

Fig. 16. Rolling-table for Green tea, used for rolling and compressing the bags of leaves; diameter, 4 to 6 feet, height, 3 feet; made of thick planks, deeply grooved on the inner side, to cause the bags to roll.

NOTICES OF CHINESE AGRICULTURE AND ITS PRINCIPAL PRODUCTS.

BY S. WELLS WILLIAMS, LL.D., AUTHOR OF "THE MIDDLE KINGDOM."

Agriculture has held a higher place in the estimation of the Chinese, in comparison with other pursuits, than among any nation of which we have definite knowledge. Their ancient writers class the pursuits of mankind into the four divisions of scholars, husbandmen, mechanics, and merchants, and estimate their rank and importance in the State according to this series. The fabled founder of agriculture, called Shin-nung, *i. e.*, the Divine Husbandman, was likewise one of the five sovereigns, who are regarded as the founders of the black-haired race of China; he flourished during the fourth and fifth centuries after the deluge, and is now worshiped as one of the tutelary gods of the Empire. The ceremony of ploughing a field near Peking is performed every spring by the Emperor or his proxy, and by the high officers of state at court, while the provincial governors imitate his example on the same day in their respective jurisdictions. This honor paid to tilling the soil dates from very ancient times, and the progress of the Chinese, beyond their immediate neighbors, in wealth, population, and general security, through a series of ages, has been owing, it cannot be doubted, to their early legislation upon the rights of landed property and the estimation in which farming has been held.

The laws at present in force regulating the possession, transfer, and liabilities of land, are substantially the same as in the days of Confucius, twenty-four centuries ago. By these laws, the Emperor is declared to be the universal landholder, and all lands are held subject to his will. The possessor is allowed to remain as long as he pays the taxes and cultivates the soil, all improvements and crops being guaranteed to him. The land is held, for the most part, by the heads of clans and old families, by whom the taxes are paid, and who lease portions of it to their clansmen or kinsmen on shares or for a percentage of the produce. The cost of transferring and registering deeds of land is nearly one-third of the sale price, and this in-

duces owners to mortgage their real estate rather than sell it, so that they can hereafter redeem it if they are able. Unregistered land and parcels regained from the water can be cultivated by any one who shows his ability to occupy them; and the laws respecting the ownership of such plots and the redemption of land are not severe. There are no game-laws or fishing privileges, and the use of rivers, lakes, and canals are open to all for navigation, or irrigation. Taxes are paid nominally in kind, but are generally commuted for money according to certain rules; though large quantities of produce and manufactures are annually carried to Peking for the supply of the State. In cases of bad seasons, the people claim and generally obtain a diminution or remission of taxes according to the disasters of the year; but the needs of government sometimes urges the husbandmen to extremity and revolt when their taxes are in arrears. On the whole, however, the burdens of the State do not heavily oppress the agriculturalist; and land is regarded by all classes as the surest investment.

The greatest aim of Chinese husbandry is to obtain as large a supply of food for man as possible in the simplest manner, and from the smallest space. To accomplish this the land is actually subdivided into small portions, so that the entire energies of a laborer are often devoted to the cultivation of a patch not many times larger than the hut he lives in; though it is more frequently the case that the tenant hires workmen, especially in raising the great staples of food and clothing. The population of the province of Che-kiang, is nearly the same as the number of its square acres. No land, to speak of, is cultivated expressly for the sustenance of animals, which are fed by their owners upon the refuse of their fields and gardens, or led off to browse upon the untilled hill-sides. Nor do large preserves for game, parks for ornament, or domains reserved for imperial show, take up land suitable for food; they may have done so once, but the demands of hungry labor have long since covered such places with crops and hamlets. The lands which are untilled consist chiefly of marshes, bogs, or wastes, which require a larger outlay for drainage, ploughing, and manuring them than would be repaid their owners; or the slopes of hills and woodlands, which are left for the growth of timber and fuel and the pasturage of cattle. The statistics of China furnish no data to form an estimate of the proportion of arable to wild land, or of the amount of food obtained from the acre, or of the number and succession of crops in various portions of the Empire. The results of this labor upon the soil are seen in the dense population and comparative easy circumstances of all who will resolutely work at their calling, and from this may be inferred its adaptation and general success.

In respect to climate, soil, and facilities of internal navigation and irrigation, the eighteen provinces of China are, on the whole, superior to any equal area on the globe. This region contains about 1,350,000 square miles, lying between the Eastern slopes of the high table land of Thibet and the Pacific ocean, ribbed by three or four low ranges of mountains, forming as many basins, through which large rivers and their tributaries find their way from West to East across the country into the ocean, irrigating, draining, and connecting every part of it. The climate is colder on the same latitude than that of the United States East of the Mississippi; but the position of the mass of land is further South, between 20° and 40° North latitude; this greatly facilitates the growth of tropical products in the Southern Provinces, for it gives a really wider range of climate between summer and winter.

The Chinese have been well called gardeners rather than farmers, for they are almost wholly ignorant of those principles by which agriculture is placed upon a scientific foundation; but practice and observation have not failed to teach them the surest way of raising a crop and restoring to the soil the materials taken from it. The requisites in their system are manure, water, and ploughing, and their whole energies are devoted to obtain them. The implements of husbandry are simple, and need not be described, for all of them are inferior to our own. The plough and harrow are worked by asses, buffaloes, or oxen, but the hoe and mattock, watering-pot and dibble, bill-hook and rake, or other aids to labor are worked by hand. The plough is so slender a machine that it is not uncommon to see a man carrying it and the harness home on his back at evening. The hoe is made of wood, having the edge of the broad blade guarded with iron, and in soft rice grounds is an efficient tool. Boats of various sizes do much to supply the place of carts, and when they are useless the huge buffalo carries home the crop he helped to till, or, more frequently, the laborer himself transports it to his house. Wheelbarrows of various sizes, sometimes drawn by asses and guided by men, are largely used for transporting goods and passengers.

The soil generally lies fallow during the winter, but in the Southern Provinces the fields near towns furnish two crops annually. The ground is pulverized and mixed, and the mingling of sand or clay with their opposites is well understood; new surfaces are exposed to the air during these operations, which itself is a great fertilizer. For manure the Chinese collect everything of a vegetable or animal kind that can be applied to such a purpose, and occasionally plough in a crop of clover, or lay leaves under the flooded soil to furnish a basis. The sides of streams and fields, highways and byways, as well as the houses and streets, are provided with conveniences for collecting and depositing night soil, and its transportation

furnishes employment to great numbers. Huge earthen jars and brick reservoirs are sunk at convenient places for the use of passing travellers, and buckets are placed in the streets. Children and others collect refuse vegetables and dung in the streets and lanes, sweep the streets, and bring together ashes, old mortar, hair, feathers, horns, bones, and butchers' offal, which they sell to the gardeners near by. The sewers of the streets are opened from time to time, and the muck carried away in boats. At low tides, or when the summer heat reduces the water, the silt of creeks and ponds is scraped up from their bared banks and laid over the fields. This alluvial is much prized by florists, as furnishing a strong soil for their plants. Old plaster is carefully collected when houses are pulled down; for the mortar, being chiefly obtained from marine shells, contains more fertilizing matter than that from stone lime. The droppings from styes, kennels, barnyards, and henceries are thrown into the common stock and mixed with earth and vegetables to form compost heaps. The scavengers, who collect their loads in towns and cities, carry them through the streets early in the morning in buckets and baskets and sell them to their customers, or else mix the muck with earth and form the compost into cakes to be dried for exportation further into the country. These manure cakes are sometimes brought to China even from Siam, and form a common article of internal freight. The mash of beans, groundnuts, and other oleiferous seeds, after expressing the oil in the mills, are purchased as manure, and, like the earth cakes, form an important article of trade.

Compost and decaying vegetables are ploughed or hoed into the ground, but animal manure is usually made liquid and ladled directly upon the growing plants. Aquatic plants require less than garden vegetables, and furnish a larger return of food in proportion to the labor bestowed. Some seeds, as rice and broccoli, are put into liquid manure until they germinate, while nuts and some other sorts are planted in a fertilizing envelop.

The various degrees of temperature and sorts of soil in China require alterations in some of the details of agriculture, and the different crops in the North and South involve many changes in tools, carts, and animals; but there is a strong likeness throughout the whole country in the general operations of the field. Irrigation is diligently attended to, and some of the means resorted to for raising and distributing water are highly ingenious, though the machines are simple in their construction. Along the high banks of rapid streams water-wheels of bamboo are often placed in such a manner as to be turned by the force of the current and fill the buckets on their rim, whose contents are thus raised and poured out on the fields 30 or 40 feet above the stream, and in some of the larger size to the extent of 150 tons a day. In localities that do not admit of such wheels they are arranged to be worked with buffaloes, as in Egypt; tended by the younger members of the family, the huge animal is urged on his weary round during the livelong day. If the soil is alluvial, as along the banks of the Pei-ho, wells are dug in the fields into which the water percolates, thence to be raised by sweeps. Fields situated within the reach of tidewater are flooded at will by means of sluices; or, if the elevation is beyond it, rude chain-pumps are placed on the banks, and the water raised by men working the axle like a treadmill. In this manner large tracts of land are rendered more fertile, and crops raised at times when they would not naturally mature. In parts that are susceptible of easy terracing, reservoirs for receiving the rain or retaining the surplus of rivulets flowing along the hill-sides are sometimes made high up so that their contents can be distributed adown the slopes; or, what is more common, the rivulet is itself led at will upon the terraces, down which the water flows in refreshing lapse from one to the other until it reaches the fields at the foot, or is exhausted in imparting fertility and beauty to the ground. Tanks are dug in gardens, too, to receive the drainings of sewers and showers, whence the water is raised by well-sweeps or buckets to fertilize the growing plants. Two men will dexterously and rapidly raise the water six or eight feet out of these tanks by means of a bucket suspended between them on ropes. Cesspools for retaining the drainings of yards and pens are placed near houses and their contents sold to the gardener. In fact, little is lost that can be used as a fertilizer because there are so many people who can collect and apply it to the land, and partly from the demands made upon the soil to provide food for the people. Some of the modes of irrigation, by diverting the course of rivulets, whose waters now run to waste, might be adopted with advantage in this country. But it is in the habit of saving all refuse which can be serviceably used as manure that the Chinese best exhibit their economy, and provide means for repairing the exhaustion of the soil. It is, doubtless, a great nuisance to have a file of scavengers passing through the streets every morning, because they have found no means to deodorize their noisome loads; but their labors conduce very greatly, it cannot be denied, to the general healthiness of the cities, by daily cleaning thousands of jakes and buckets, the contents of which would otherwise putrify and be injurious. The arrangement of earthen jars or brick cesspools to receive the drainings and offal of yards and kitchens is, however, one of the ways adopted by the Chinese to collect liquid manure that presents no such objections, and might prove amply remunerative for all the trouble it

involves. The largest of these jars contain a hogshead, and the various sizes are manufactured in vast quantities to supply the exigencies of houses and boats.

Compared with Europeans, the Chinese rear and use domestic animals far less. The buffaloes, oxen, and asses which are employed in agriculture are fed during the summer with the grass cut for them on the hills or waste corners, or are allowed to browse there when not working; the deficiency is supplied by the refuse of the kitchen and garden. Animal food chiefly consists of poultry, pork, fish, and whatever else is found in the water, ducks and other water fowl, with a small proportion of mutton, beef, and horseflesh; and a far less one of the flesh of dogs, cats, rats, and deer. The raising of cattle, goats, and sheep for the table is almost unknown; but the demand for their labor and hides is such as to remunerate their owners, and droves of them are not uncommon in the central provinces; goats are used in some regions to carry home the crops. Fodder of leaves, grass, stubble, and twigs is collected for winter use, and supplies the deficiencies of grain and hay for the food of horses, mules, asses, and cattle. They need no shelter during the winter throughout more than half the country, and even then pick up no small part of their own support. While the Chinese thus supply themselves with animal food very well, they also contrive to subsist on that which costs the least labor to rear it, and consumes what man does not want.

Wooden fences are unknown, except bamboo wattles, and the space occupied by roads is trifling. Hedges of bamboo, pandanas, rhamnus, and other shrubs surround gardens or protect fields; but low dykes and shallow ditches more commonly divide the fields of grain. Stone or adobe walls are raised around the grounds of dwellings or the folds of animals.

A brief account of the cultivation of a few of the staples of Chinese agriculture will exhibit other agricultural operations. Among these the article of Rice stands prominent, and occupies more of the land under culture than any other crop. The outturn of this grain affects every branch of labor as much as the wheat crop in England; and the energies of the husbandmen are chiefly directed to bringing it to perfection. The cultivation extends as far North as the Yellow river, in latitude 34°; but it is in the rich lowlands of Kwangtung and Kwangsi, or Formosa, that this cereal is most abundant. The price of land there depends very much on its adaptedness to growing rice; and the rate of wages, rent of land or houses, and even the pay of soldiers depend much upon the amount and value of the rice crop. More than thirty years ago the government at Canton offered a high bounty upon the importation of rice, and the tariff still liberally discriminates in favor of foreign ships laden with it.

There are many varieties of the grain, some of them white, like the best Carolina rice, deteriorating in color to a dark brown, with other shades of red, including too the glutinous and the mountain rice, which some botanists regard as distinct species. The sorts of upland rice are few, and their cultivation comparatively small. In the vicinity of Canton the rice fields are prepared by ploughing and flooding during the month of March, and by the first week of April, if possible, the shoots are transplanted. The plough and the harrow are successively used to pulverize the wet soil; a buffalo, whose huge weight itself aids no small degree in turning up the ground, draws the machine. The grain is first soaked in liquid manure and then sown thickly in beds of rich muck, where it soon sprouts; when the shoots attain the heighth of six or eight inches they are taken up for transplanting. Holding his left hand full of them, the laborer takes six or eight off at once and sticks them into the mud at each step as he walks across the field; seldom is it necessary to renew them. The rice throughout China is all transplanted, and doubtless the extra labor is more than recompensed in the increased crop. It seems more like the operations of magic than of agriculture to see such a barren, oozy marsh transformed in four or five days into a beautiful green carpet of growing grain. The water is kept upon the ground at least until the stalks attain their full size, or else the crop is materially injured; it gradually dries up, and when the field is ready to reap none remains. The grain is cut with billhooks near the ground, and either bound into sheaves to carry to the threshing floor or else beaten out into a large tub in the field, by the reaper striking it over the rim, a mode which preserves the straw better than threshing it by flails.

As soon as this crop is off the ground it is prepared again for the second, for the shoots have been already sprouted for transplanting. Comparatively little manure is used in rice cultivation, the pulverizing and flooding the soil apparently supplying its exhaustion. The first crop is cut in July, the second in November; and two harvests are annually obtained on most of the lands which can be flooded by tidal waters or rivulets. After the rice (paddy as it is called when the husk is on) is threshed out the glumes are separated from the grain by pounding it in mortars or rubbing it between boards. The skin of the naked grain is separated by pounding it again in stone mortars with stone or heavy wooden pestles, worked by the feet or with water power, until it is clean. Boats are anchored in streams out of the way of travel, in which these pestles, or even millstones, are turned, by wheels worked by the rapid current. Overshot water-mills and ox-mills are also known and used. The price of

common rice in China varies from two to three cents per pound, rising in times of scarcity to five cents, a rate too dear for the lowest ranks of society. The average crop yields an increase of twenty-five or thirty fold.

Wheat, spiked millet, *(Setaria,)* sugar-cane, and maize are other cereals cultivated in the South of China; and the Sorghum millet, the panicled millet, *(Milium,)* buckwheat, barley, and sesamum increase the list of grains in the northern provinces. They are sown where rice will not easily grow, and their cultivation occupies the largest part of the arable land in those regions. The lowlands produce many kinds of aquatic vegetables, some of which are alternated with rice. Among these the *ling*, or water calilops, *(Trapa,)* ranks first, and supplies vast amounts of food. Its cultivation is in running water, and the nuts are collected in autumn by people in *punts*, or tubs, who look for the ripe ones as they pull themselves through the vines over the surface of the patch. The dried nuts are often ground into a sort of arrow-root flour; the taste of the fresh boiled nuts is like that of new cheese. The esculent root of the *scirpus*, called from its color and shape the water chestnut, is extensively raised at the South, and serves as a table vegetable when fresh and for flour when dry. Its taste is like that of salsify. In addition to these two a species of Aroideæ, *(Caladium,)* the taro, and the water lily or lotus, are grown in marshy plats, or in ditches and pools which need to be covered. No field can compare for beauty to a field of water-lilies when in flower; the large pink blossoms appearing among the shining peltate leaves, both raised on stalks three feet high, and covering the entire surface. The long roots are boiled for food or ground to flour, the seeds are used as a nut, the dried culms are burned as fuel, and the leaves are hoed in for manure. These economical uses are all in addition to its religious uses, for the lotus has become so identified with Budhism, in all its idols and paintings, that few persons who have lived in Asia can dissociate it from that faith.

These aquatic vegetables are produced with rather less labor in manuring and pulverizing the soil than upland vegetables, for one deep hoeing is sufficient to prepare the field for a new crop, and the succession of crops is not long intermitted in the mild climate of Southern China. Fields near tidewater are not unfrequently converted into fish-ponds during the winter, the spawn and young fry being easily procured from tanks in town, and fed with abundant food from a species of Azolla scattered over the surface; carp, tench, silures, and other soft-finned fishes are reared in these extempore ponds. Whether the cultivation of marshy and flooded lands, even after a people have, as here, become acclimated during many generations, is detrimental to their health and physical development in comparison to upland and dry soil husbandry, may be still questionable; but the Chinese in these lowlands do not, in any respect, come behind their countrymen in the Northern Provinces.

Next in importance and extent to the cultivation of rice is that of Cotton, which has been known in China only in comparatively recent times, in the 11th or 12th centuries, when it was brought to the South by sea, and to the central Provinces across the Western frontiers. The Chinese name is *mien*, and some suppose that the Western word *cotton* is derived from the country of Khoten, in Central Asia, whence it early found its way South to India and East to China. The limits of the cotton culture are greater than those of rice, as they reach North beyond the Yellow river, but the area is far less; it is comparatively a minor crop South of the Meiling mountains. Chinese writers give many directions respecting the cultivation of cotton, and a few condensed extracts may interest the reader.

"Select rich ground for cotton, not that which is damp. Plough the soil deep in February three times, turning in the manure; spread the earth evenly and make the beds about fifty feet long and eight wide, sloping off from the centre. Do not dig up the earth again, but harrow the beds smoothly and heap the earth on them to make them slope. The trenches between the beds are two or three feet wide; the leaves are swept down into them and rot, and in winter the muck is spread on the field. About the end of April, the dikes and beds being in order, water the ground three times; wash the seeds thoroughly, putting them into wet soil, and the next day rub them with ashes slightly, and then sow them on the watered bed about a pace apart, covering them a finger or so with the earth heaped up, not watering it again at present.

"In six or seven days the shoots will spring up uniformly—water them in dry weather, hoe and weed the beds clean, and if the plants are growing too thick transplant them, otherwise the fruit will not set well. When they are two cubits high, break off the middle or heart shoot, and also the leading stem of the branches when they are twenty inches long, for by this means the blossoms will appear and the fruit set; the tops should be constantly nipped off, lest the seed do not set. In order to select the best seeds for planting, steep and stir them all in water for fifteen minutes, when the old and shriveled ones, the empty, the fire-dried, the oily and rotten seeds, will all float, and the solid, hard, clear-black, sound ones will sink. It is better to be thus careful in selecting seeds than to sow a peck to each *mau* (6.6 of an acre) and have only a portion of them sprout. A gill of good seeds, each planted three feet apart, will be enough for a *mau* of ground. The seeds first gathered are not fully ripe, and those collected near the hoar-frosts are useless; the best are picked in

the intervening season, and should be dried in the sun and laid up with the cotton around them, separating the two when the time comes for sowing. The seeds are pressed out of the bolls by simply rubbing the flowers, when thoroughly dried, upon a board running between iron rollers; they are also picked out by hand.

"At the proper season, the broad bean is sown, and in the spring it is turned into the ground for manure, making the soil high and allowing the cotton roots to spread and strike deep. Plentiful manuring, and planting the seeds in rows about a pace asunder, so that the branches shall develop until they require to be nipped about flowering time, are requisites to an abundant crop of cotton. Good lands and careful cultivation should, in favorable seasons, yield betweeen two and three peculs to the mau, (*i. e.*, 1,600 to 2,300 pounds, to the acre.) Manure is applied to the growing plants, as they seem to need it; and after the crop has been gathered, and the cotton stalks pulled up for fuel, the field should be ploughed in autumn to lie broken up all winter. After two crops of cotton, rice can be profitably grown on the ground; for after three successive crops of cotton insects begin to appear. If after the third season the soil is too poor for rice, raise dykes around the fields and flood them during winter; in the spring draw off the water and plough deep, hoeing it well. The land should be manured, about the middle of April, with night soil, ashes, oil-cakes, or fresh earth taken from ditches. Another way is to sow yellow clover in autumn, and the next year cut the tops to apply to the rice fields, ploughing in the roots; if the clover be not strong, increase it with something else, for the sub-soil should be thick, and a sub-soil made of weeds in this way produces a better harvest than any other kind of manure. In some places barley is sown in the autumn, and when it is time to plant cotton the growing grain is turned in with the plough, whereby the stalks will be about the cotton, and protect it from cold, enabling the farmer to put his seed into the ground ten or fifteen days earlier than he could otherwise."

Care must be taken to hoe cotton deep, and in order to have it done thoroughly it is reported that formerly masters used to secrete copper coins about the roots of the plants to stimulate their workmen to sift and "comb out" the soil to find them. The plants in the region near Shanghai do not usually rise more than three feet, and their bolls are small, owing perhaps to the low and damp soil; better cotton comes from Shantung Province, North of the Yellow river, but the best is said to be produced in the regions East and North of Nanking. There is considerable difference in the color of the staple, and the yellowish sort, which furnishes the cloth commonly called *nankeen*, is more common in those parts; but the Chinese themselves generally prefer to dye their cotton cloths blue. Since its cultivation became known, it has spread through all parts of the empire, and compared with silk and hemp it is a hundred times more useful, rich and poor alike relying on it for garments. The proportion of the crop furnished as a tax to government is reckoned at a million of peculs, and the entire crop of China doubtless much exceeds that of the United States. In 1834, the importation of raw cotton into Canton from India was over 400,000 peculs, or 53,000,000 pounds; and this amount made no sensible difference on the cultivation in the Central Provinces. The staple is short in comparison to that produced in other countries, but the cloth is remarkable for its durability, and furnishes the garments of the mass of the Chinese people.

The cultivation of the Mulberry employs a large portion of the population in the Eastern and Southern Provinces, and is continually extending, from the increasing demand for European manufactures of every kind of raw silk. Chinese works furnish some particulars for the guidance of the cultivators of this plant. They divide it into two sorts; one from Hickwang, in the Central part of the Empire, and the other from Shantung, in the North-east. The former has large leaves and few berries, with firm roots; the latter has small leaves, abundance of fruit, and tough branches. The most prolific kind is obtained by grafting the latter upon the stock of the former, covering the insertion with a thin coating of mud. In the spring, when the buds sprout, only one shoot is to be kept, and by autumn the plant will be formed. The suckers are set out in a quincunx, and in the spring of the next year cut them down to about two feet, and clip off the top stem to force out the suckers, of which only two should be left to grow. In the third spring the branches are again pruned, leaving only the upper to divide. This operation is performed every spring, cutting off all the suckers except the upper fork, and the plant attains its full growth in the fifth year and can be stripped of its leaves for the silk-worms. Every May the tree can be pruned at the knobbed ends of the branches, and the leaves collected with the twigs, drying them, if necessary, before feeding the worms.

The mulberry requires rich soil, and is continually pruned to force it to develop new twigs for the sake of their leaves. The ground around the stalks is hoed, and manure of oil-cake laid at the roots to stimulate the suckers, which are eight or nine feet long by autumn. The twigs are stripped of leaves by scraping the hand along, allowing the two leaves at the outer point of each to remain; two or three crops are obtained during a season. The space between the rows of mulberry is also occupied by other crops, which come to

maturity at different times; cabbages, pulse, and turnips are among them. In some plats the trees form merely the border, and the vegetables engross most of the land, which arrangement may be changed the next year and the demand for silk induce the husbandman to transplant suckers over the whole, leaving the interspaces only for greens.

Besides cotton and mulberry, there are several other plants cultivated for their fibers to weave into garments, or for their oils and dyes to use in the arts. The native linen, erroneously called by foreigners *grass-cloth* from ignorance of the plants which furnished the fiber, appears in market of every degree of fineness, from coarse sleazy bagging to the most delicate tissues. It is generally called *ma*, or hemp, and the better sorts are named *hia-pu*, meaning summer-cloth. It is made from three different plants, the *Urtica nivea*, the *Dolichos bulbosa*, and the *Sida tiliæfolia*, to which some observers add the *Corchorus capsularis*. The hemp, or Cannabis of some authors, has been shown to be either a variety of *Urtica nivea* or the *Boehmeria tenacissima*, an allied plant. The *Urtica*, or hemp nettle, is cultivated, more or less, from Chusan South to Cochin China, and furnishes a large portion of the material for the "summer-cloth." The mode of cultivating it is described by Chinese authors, from whose directions a few sentences are condensed.

"When sowing the *choo-ma*, or nettle, in the months of May or June, select a sandy, light soil; it is sown in gardens, or near a stream or well. The earth is dug over once or twice and formed into beds, half a foot wide and four feet long, after which it is dug again. The earth is slightly heaped up with the foot or the back of the spade, and, when a little hardened, levelled with a rake. The next night the beds are watered, and in the morning the earth is slightly turned up with a toothed rake. The seeds are mixed with moist earth, in the proportion of about one to three, and sowed upon the beds, a fifth of a pint of seeds being enough for six or seven beds. After sowing it is unnecessary to cover the seeds with earth, for, if covered, they will not grow. Four sticks are then driven into the earth, at the corners, to support a mat roof, three or four feet high, and during the heats of summer this thin mat is covered with a layer of straw, otherwise the shoots will be destroyed by the heat.

"Before the plant germinates, or when the shoots begin to appear, they do not require to be watered, but the mat covering is wetted to retain the moisture in the ground; and every night the matting is removed in order that the young plants may receive the dew. Weeding must be carefully attended to, and when the shoots are two or three fingers high the covering is no longer necessary. Other beds are now formed in strong soil for receiving the shoots, and when prepared, by manuring and watering, the young plants are taken up by the spade, with earth remaining around their roots, and set out four inches apart. The ground is often hoed and watered for the first time five days after transplanting. After November they are covered with a foot thick of manure compost. After some years the roots increase and become entwined together, so that it is necessary to separate and replant them by layering the suckers as is done to obtain mulberry plants; some farmers bury the stalks lengthwise in the earth and thus obtain layers. When a bed becomes too crowded a new one is prepared, which is soon followed by another, whereby the number of plants is indefinitely increased. As soon as the young plants are some inches high they are sprinkled with liquid manure. After cutting the stems they should be watered immediately, but not in the full sunshine lest they rust.

"This plant yields three crops annually, the first in June, when care must be taken not to cut the shoots; the second two months after, when the shoots are seven feet high. The last is in October, and furnishes the finest fibers. After each cutting the plant is to be covered with manure and watered. The leaves are cut from the stalks and left on the spot; the soaking need not be longer than an hour, when the stalk is broken and the fibers detached lengthwise with the finger nails—an operation usually done by women and children. Others draw the stalks over a pin to detach the fiebr. The next process is scraping the hemp by drawing it across the dull blade of a knife under the thumb, which presses upon the fibers so as to remove the pilous part of the surface, and scrape off the mucilage at the same time. After this sort of hatcheling they are dried and sorted. A partial bleaching is effected by boiling the fibers, or pounding them on a plank with mallets. After drying them in the sun, women and children split them with their nails still finer, hatcheling them a little to assist the separation. Threads are loosely rolled into balls, and subjected to frequent soakings and washings, ashes or lime being used to assist the bleaching. Some simply expose them to dew and sun. The threads are now ready for splicing and weaving—operations done by women and children. Before putting the threads into the looms, the balls are steamed over boiling water in a closed oven, and then spread out to dry."

The Sida resembles the *abutilon* sometimes reared in gardens in America as an ornamental flower, and occupies extensive fields along the banks of the Pei-ho and elsewhere in Northern China. The stalks grow six feet high, and are gathered soon after the blossoms fall, and rotted before the fibres are drawn out. This plant furnishes material for cordage, twine,

and thread, as well as cloth. Ropes of every size for rigging, cables, and hawsers are manufactured from wiry fibers obtained from the bark of a species of palm (Chamærops) growing in the South of China, and applied to the various purposes of navigation under the name of coir ropes.

The *Dolichos bulbosus* is a creeper, whose large coarse roots furnish food to the poor when boiled, or flour when dried and ground up. The fibre is loosened by boiling the stalks, then taken off by the nail, washed in running water, and beaten by mallets. It has long been woven into a sort of linen of a yellowish brown in color, and some of it as fine as grass-cloth. The people of Canton, Amoy, and thereabouts cultivate the plant largely for the table and the loom.

The *Isatis Indigotica* at the North, and the *Polygonum tinctorium* in the South, are largely cultivated for their blue dye, the Chinese preferring this color for their garments. A great number of plants are grown in various parts of the country for the oil found in their seeds or nuts, which is consumed in cooking, burning, or in the arts, while the refuse cakes taken from the oil mills are returned to the ground as one of the best manures known. Oil is expressed for these purposes by simple pressure from the ground-nut (*Arachis*) throughout the Southern and Central Provinces, and the nut itself is baked for food. Rape oil is obtained from the seeds of two or three sorts of cruciferous plants, the principal one of which is the oil cabbage. Castor oil is used in cooking, but less extensively than the Sesamum; both of these are largely raised, the latter particularly, in Chihli and other Northern Provinces. The Camellia sesanqua and oleifera are also cultivated for the oil in their nuts, which is sold under the name of tea oil, the native word for the proper tea plant and the Camellia being the same. A species of Croton, the *Jatropha curcas*, is reared in the South for the sake of its oily nut, which furnishes a material for varnishing wood-work, and a drying oil in painting. Its strong frouzy odor is sensibly perceived in all the boats which ply for passengers around the cities on the Southern rivers.

Sugar cane occupies an extensive proportion of the rich lowlands along the Southern coasts from Hainan to Fuhchau, and the traffic in sugar to the Northern cities gives employment to numerous ships. The cane is slender, white, hard, and by no means rich or juicy; yet, abating the fungus powder which soon covers it, the surface is healthy and close-grained. As it grows to maturity the farmers tie the stalks together for security against the wind, and the outer plants in a patch of cane are mutually supported by diagonal leaves passing from one to the other, which serve at the same time to form them into a rude fence against cattle. The raw and boiled cane are continually hawked around the streets, and the leaves are one of the chief articles of fodder in that region.

The list of leguminous and cruciferous plants cultivated in China is a long one, some found in one part, some in another, and a few in all. Peas and beans of many sorts form a large portion of the food of the common people, either boiled or as greens. An emulgent preparation of flour from the Dolichos bean, mixed with ground gypsum or tumeric, and a touch of salt, called bean curd, accompanies every meal; the same materials, differently prepared, is sent abroad as Soy. Cabbages, kale, turnips, mustard, cress, broccoli, radishes, and cauliflower, with many varieties and novelties, supply the Chinese with vast amounts of food, cooked and raw, fresh and pickled, besides the refuse left for cattle and compost. So do the numerous sorts of melons, cucumbers, squashes, and pumpkins, which need only be referred to; they are very abundant, but usually deficient in flavor to those grown in Western countries. Carrots, tomatoes, egg-plants, okra, onions, cives, garlics, and *brinjal* swell the list of their vegetables, but by no means includes nearly all of them. The total amount is vastly increased by the sweet potatoe, Chinese yam, and Indian yam, (Dioscorea,) until the assortment and quantity are prodigious. The Chinese yam flourishes best North of the Yangtsz Kiang, The Irish potato is grown chiefly for foreign consumption, and has not found favor with the people.

It is on those Northern plains that the millet grows so abundantly. The *milium* or panicled millet is one of the most elegant of the cereals, resembling oats in size and color, and prolific, too, for one stalk taken at random yielded 1,850 seeds. The Barbadoes or Sorghum millet presents a strong contrast to it, for the stiff culms of this grain rise to the height of fifteen or sixteen feet, and when the lower half has been stripped of its leaves for the cattle, a field of them looks like a miniature forest. The taste of boiled millet resembles that of fresh hominy, and the predilection of the natives for this grain probably prevents the rapid introduction of Indian corn, which, however, still appears to find favor as it becomes better known. The stalks of the Barbadoes millet are extensively used in Northern China, as they are in Egypt, in the construction of poor dwellings. They are placed crosswise in such a manner as to support the mud laid between their rows, and this wall, after drying, is plastered carefully to protect it from the weather. They are also used for strengthening dikes and constructing fences, and, not the least of their uses, for fuel.

The assortment of fruits known among the Chinese is large, comprising most of those common in the United States, and several peculiar to the country. It is needless to describe

the apple, pear, quince, plum, apricot, or peach, for they are generally inferior in flavor to those here, with the exception, perhaps, of the two last, which furnish some delicious sorts. The flat peach is a singular shaped variety, peculiar to China. Among native fruits the orange takes the first place in abundance and variety; including all the species of orange, lemon, and shaddock, and their varieties, there are more than twenty sorts, the most delicate of which is the *citrus nobilis*, or mandarin orange. The shaddock often grows to the size of a small pumpkin, but at the expense of its flavor, and the citron orange is kept for weeks in rooms on account of its agreeable perfume. Four or five varieties of the persimmon come to maturity during the autumn, some of them as large as oranges, and all furnishing wholesome food in great abundance. The *loquat*, or *pe-bo*, (Eriobotrya,) resembles the medlar, but is superior to it in flavor and size. The *li-chi*, or *lyche*, is another of the common fruits of Southern China; the seed is enveloped in a white sweet pulp, protected by a leathery skin; when ripe, the color and shape of this fruit reminds one of the strawberry. The persimmon, whampe, loquat, and li-chi, are among those fruits of China which might profitably be introduced into the Southern States, for the climate and soil in their native country can both be matched there. The *whampe* (or yellow-skin, as the name signifies) is another fruit confined to the Southern Provinces. It is a small tree, bearing clusters of grape-like, juicy berries, of a pleasant acid taste. It is only necessary, in this connexion, to mention the names of the plantain, carambola or tree gooseberry, pomegranate, mango, custard-apple, pine-apple, cocoanuts, citron, fig, guava, olive, and grape, to show the extent of the list of the fruits of China, for their description forms no part of the object of this paper. Nor have all been mentioned. Walnuts, chestnuts, almonds, and the seeds of the Salisburia, or *gingko*, and water-lily, and the dried plums of the jujube tree, might also be mentioned. The last are usually, but improperly, called dates.

The cultivation of tobacco reaches as far as that of wheat, and the crop is far greater in amount. It is milder than the Manilla plant, and the prepared leaf is used for smoking by nearly all of every class, age, and sex. The poppy has, like tobacco, been introduced into China from abroad, and the preparation of opium from it is gradually extending to furnish a cheaper article than the Indian drug. Tea, cassia, and camphor are well known products of the Chinese Empire, the cultivation and preparation of which furnish employment to myriads of its inhabitants, and need not be particularly described. The list of plants raised for their medicinal qualities, as China-root, ginseng, cubebs, ginger, turmeric, &c., is a long one; to which might be added the star-anise, tallow-tree, cinnamon, the varnish, or lacker tree, gambier, and other plants not so well known abroad, raised for use in the arts. The mode of cultivating many of these articles are still imperfectly known to foreigners, and there are probably many items of curious and useful information to be learned as more is ascertained of their details.

This outline of Chinese agriculture and its chief productions would be incomplete without an account of the growth and uses of the bamboo, which are so numerous as to entitle this grass to be called the national plant of the Chinese. It grows naturally throughout the country nearly to the latitude of Peking, diminishing in size and strength as one goes Northward. The varieties induced during the long period of its culture are numerous, and a native writer on its propagation observes at the outset of his treatise that he could not undertake so much as to name them all, and would therefore confine himself to a consideration of sixty-three of the principal. Some of them are like trees, forty or fifty feet high, with culms eight inches in diameter near the root; others resemble pipe-stems through their length, graceful and slender as a magician's wand; while one kind presents a black, and another has a bright yellow skin. It is cultivated in and near villages for its shade and beauty, and a grove furnishes culms from year to year of all sizes. No plant imparts so oriental and rural an aspect to a villa or hamlet as the clumps of this graceful and stately grass, the wavy plumes of which, swaying in every breeze, form an object of great beauty, well befitting so useful a plant.

The bamboo may well be called useful, for it is applied by the Chinese to such a vast variety of purposes that they are puzzled to get along without it when they emigrate where it does not grow. It is reared from suckers usually, but it is necessary after a time to renew the plants from the seed, as it dies down to the root like other grasses after it flowers. Native authors say that the size of the stalks can be increased by cutting off the shoots and filling the topmost joint of the main one with sulphur for three years, after which the shoots will spring forth with great vigor. It is rather difficult to transplant it, but when once rooted the suckers annually extend till a clump of a hundred stalks is often produced. The tender, but tasteless shoots are cut for food, either boiled, pickled, or comfited, as the customer wishes; but not the "tender buds and flowers cut like asparagus," as one writer on China describes. The seeds, too, furnish a farina suitable for cakes, and the Chinese have a proverb that the bamboo flowers chiefly in years of famine.

The gnarled roots are carved into fantastic images of men, birds, monkeys, or monstrous perversions of animated nature; cut into lantern handles or canes, known in commerce as

whangees; or turned by the lathe into oval sticks for worshippers to divine whether the gods will hear or refuse their petitions. The tapering culms are used for all purposes that poles can be applied to in carrying, supporting, propelling, and measuring, by the porter, the carpenter, and the boatman, in all cases where strength, lightness, and length are requisites. The joists of houses and the ribs of sails, the shafts of spears and the wattles of hurdles, the tubes of aqueducts and the rafters of roofs, the handles of umbrellas and the ribs of fans, are all constructed of bamboo.

The leaves are sewed upon cords in layers to make rain-cloaks, swept into heaps for manure, matted into thatches, and used as wrappers in cooking rice dumplings. Cut into splints and slivers of various sizes, the wood is worked into baskets and trays of every form and fancy, twisted into cables, plaited into awnings over boats, houses, and streets, and woven into mats for the scenery of the theatre, the roofs of houses, and the casing of goods. The shavings even are picked into oakum and mixed with those of rattan, to be stuffed into mattrasses. The bamboo furnishes material for the bed and the couch, chopsticks to use in eating, pipes for smoking, and flutes to aid in singing, curtains to hang in the doorway and brooms to sweep around it, besides screens, stools, coops, stands, sofas, and other articles of convenience and luxury in the house, too numerous and trifling to mention. The mattrass to lie on, the chair to sit upon, the table to dine from, food to eat, and fuel to cook it with, are alike derived from it. The ferule to govern the scholar and the book he studies both originate here. The tapering tubes of the native organ and the dreaded instrument of the lictor, the skewer to pin the hair and the hat to screen the head, the paper to write on, the pencil to write with, and the cup to hold the pencils; the rule to measure lengths, the cup to gauge quantities, and the bucket to draw water ; the bellows to blow the fire and the tube to hold the match; the bird-cage and crab-net, the life-preserver and childrens' buoy, the fish-pole and sumpitan, the water-wheel and eave-trough, sedan, wheelbarrow, and handcart, with scores of other machines and utensils, are one and all furnished or completed by this magnificent grass, the graceful beauty of which when growing is comparable to its varied usefulness when cut down.

China could hardly be governed without the constant application of the bamboo, nor the people carry on their daily pursuits without it. The very phrase to *bamboo a man* has almost become incorporated into our language to express the design and means of Chinese government. It seems to embellish the garden of the patrician and shade the hamlet of the peasant; it composes the hedge which separates their grounds, assists in constructing the tools to work their lands, and feeds the cattle which labor on them. The boatman, dyer, and weaver find its slender poles indispensable in their trades, while there is nothing the artists paint so well on wares and embroideries. The tabasheer found in the internodes has its uses in native pharmacy, and the silicious cuticle furnishes the engraver a good surface for carving and polishing.

The works of Fortune and Davis contain further notices of Chinese agriculture and products, and so does the Middle Kingdom, published by J. Wiley, in New York. All of these works are accessible. The periodicals published in China are not so easily obtained in this country, but most of them, as the Chinese Repository, China Mail, North China Herald, Transactions of the Asiatic Society, &c., furnish original communications on these topics. This sketch is necessarily incomplete, and is intended only to furnish some of the most prominent points of the subject.

PATENTS FOR AGRICULTURAL INVENTIONS OR DISCOVERIES FOR THE YEAR 1860.

Inventions or discoveries.	Inventors.	Residence	Date of patent.
Bee-hives	John Meese, sr.	Milton, Ohio	January 31
Bee-hives	Aaron W. Geahcart	Beallsville, Ohio	February 14
Bee-hives	W. A. Flanders, assignor to self and S. W. Boyce.	Cleveland, Ohio	March 6
Bee-hives	Robert Hawkins	Bealsville, Pa	April 24
Bee-hives	James S. Black	Bloomfield, Ky	May 15
Butter-worker	Lydia W. Stiles	Brooklyn, Ohio	May 15
Butter, Machine for printing	Jos. S. Miller and S. Lloyd Wiegand.	Philadelphia, Pa.	May 22
Butter-worker	Wm. H. Wiley	Lockport, N. Y	June 12
Bee-hives	Kimball P. Kidder	Burlington, Vt	June 26
Butter-worker	Charles A. Boynton	Hyde Park, Vt	July 17
Bee-hives	Nathan Brasher	Green's Fork, Ind	July 31
Bee-hives	Matthias W. Gonnigle	Allegheny, Pa	July 31
Bee-hives	William Hyde	Emery, Ohio	August 7
Butter-worker	Lewis S. Ingraham	Grafton, Ohio	August 7
Bee-hives	Daniel Arndt	Zanesville, Ohio	August 21
Bee-hives	Samuel Maitland	Fort Wayne, Ind	August 28
Bee-hives	E. S. Bacon	Albion, N. Y	August 28
Bee-hives	C. Williams, assignor to self and J. F. Deffenbacher.	Weston, Mo	August 28
Bee-hives	John Jacobs	Columbus, Ohio	September 25
Bee-hives	Samuel R. Bryant	Waterford, Pa.	October 2
Bee-hives	Hiram M. Shaffer	Bucyrus, Ohio	October 2
Bee-hives	J. W. Palmer and J. K. Leedy.	Port Republic, etc., Va.	October 9
Bee-hives	Ira C. Pratt	Morton, Ill	December 18
Bales, Cotton, Mode of securing metal hoops on.	John McMurtry, assignor to Farmer Dewees.	Lexington, Ky	April 10
Bales, Cotton, Metal ties for	James Aiken	Natchez, Miss	May 1
Bales, Cotton, Iron ties for	Walter Stewart	Natchez, Miss	May 1
Bales, Cotton, Iron ties for	Wm. S. Loughborough	Rochester, N. Y.	May 8
Bale-hoops, Metal, hoop-locks for	Charles H. Dubs	Natchez, Miss.	May 8
Bales, Cotton, Locks for	Ayres P. Merrill, jr	Natchez, Miss	May 22
Bales, Cotton, Iron ties for	Charles C. Bier	New Orleans, La	June 26
Bale-ties, Cotton	Z. W. & E. D. Lee	Blakely, Ga	July 3
Bale-fastening, Cotton	Thomas McIntire	Franklin Furnace, Ohio.	July 17
Bales, Cotton, Fastening for	James W. Evans	New York, N. Y	August 21
Bales, Cotton, Iron ties for	P. Davey	Portsmouth, Ohio	September 25
Bales, Cotton, Bands for	Robert W. Fenwick	Washington, D. C.	September 25
Bran-duster	J. W. Houghtelin	Du Quoin, Ill	June 26
Cultivators	Henry R. Kinney	Portsmouth, Ohio	January 3
Cultivators, Cotton	Tho. Newcomb and G.W. Byrd	Smith's Fork, Tenn	January 3
Corn-shellers	Seth Fletcher and Jn. P. Pike.	Bloomfield, Me.	January 3
Cultivators	Francis Davis	Lima, Ohio	January 3
Cultivators	F. & P. A. Misner	Fox, Ill	January 3
Cultivators	J. K. Staman	Mifflin, Ohio	January 10
Cotton-stalks, Machines for pulling and cutting.	Smith Beers	Naugatuck, Conn	January 17
Churn	Josiah P. Fitch	New York, N. Y	January 17
Churn	D. C. Brown	New York, N. Y	January 24

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.	
Churn	Lester Day	Buffalo, N. Y	January	31
Corn-shellers	L. W. Ryckman	Pontiac, Mich	February	7
Churn	Abner Willson	Colden, N. Y	February	14
Cultivators	Abner Carey	Rome, Ga	February	14
Cultivator-teeth	George C. Aiken	Nashua, N. H	February	14
Churn	Edwin Ward	New York, N. Y	February	14
Cultivators	Thomas Murphey	Cincinnati, Ohio	February	14
Cultivators	J. O. Harris and W. F. Slewder	Ottawa, Ill	February	14
Cultivators	Joseph Vowles	New Hudson, Mich	February	14
Churn	Edwin B. Clement	Barnet, Vt	February	21
Churn	A. W. Cunningham	West Middleton, Pa	February	28
Churn	David Newbrough	Clarksburg, Ind	March	6
Churn-dasher	Aaron C. Vaughan	Johnstown, Pa	March	6
Cultivators	W. W. Green	Chelsea, Ill	March	6
Cotton-plants, Machine for cutting up.	B. T. Currier	Bath, Me	March	6
Cotton-pickers, Hand	William B. Cargill	Waterbury, Conn	March	6
Cane-coverers	John Allison	St. Martinsville, La	March	6
Cultivators	Robert Craig, assignor to self and J. D. Ludlow.	State Line City, Ind	March	6
Cultivators	John J. Paxson	Middletown, Ind	March	6
Cultivators	Jimpsy B. Netherland	Louisville, Ga	March	6
Cultivators	F. O. Wilson	Mount Olive, N. C	March	6
Cultivators	Thaddeus S. Scoville	New York, N. Y	March	6
Cultivators	Edward Julier	Beverly, Ohio	March	13
Cultivators	John Guyer	Westport, Conn	March	13
Churn	Jason W. Hardie	New York, N. Y	March	13
Churn	Daniel H. Wriswell, assignor to Charles W. Adams and Debby Pinner.	Buffalo, N. Y	March	13
Churn	William Morgan	Middlebrook, Va	March	20
Churn	Pearson Embrie	West Chester, Pa	March	20
Churn	James Sangster	Buffalo, N. Y	March	20
Cultivators	Samuel Hoake	Frederick, Md	March	27
Cultivators	George Smith	Baltimore, Ohio	March	27
Cultivators, Cotton	Cullen Casey	Goldsboro', N. C	March	27
Cultivators	Cyrus M. and David E. Hall	Uniontown, Ill	March	27
Corn-huskers	Samuel Johnston	West Shelby, N. Y	March	27
Cultivators, Cotton	Mark Snow	Auburn, Miss	March	27
Cultivators	William Bushnell	Easton, Pa	March	27
Cultivators	W. D. Dorsey	Decatur, Ill	April	3
Churn	Daniel Deshon, 2d	Somerset, Pa	April	3
Corn-shellers	Nathaniel Drake	Newton, N. Y	April	3
Cultivators, Hand	P. S. Clinger	Conestoga Centre, Pa	April	3
Cultivator-teeth	Heman B. Hammon	Bristolville, Ohio	April	10
Cultivators	John G. Christopher	Byron, Ill	April	10
Churn	Edward Lynch, assignor to self and J. J. McCool.	Buffalo, N. Y	April	10
Corn-huskers	N. T. Spear	New York, N. Y	April	10
Churn	Jehu Mitchell	Aleppo Township, Pa	April	17
Churn	Stephen P. Dunham and A. Hipple.	Killbourn, Ohio	April	17
Cultivators, Corn and Cotton	G. T. Bennet	Mount Olive, N. C	April	24
Cultivators	Irulus R. Smith	Elgin, Ill	April	24
Cultivators	Joseph F. Eylar	Scott, Ohio	April	24

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.	
Corn-shock binders	Calvin Stowe	Braceville, Ohio	April	24
Cultivator-teeth	George O. Aiken	Nashua, N. H.	April	24
Churn	W. B. Gordenier	Cowdersport, Pa	May	8
Churn	Reuben J. Holmes	Worcester, Mass	May	8
Churn	George H. Van Vleck	Buffalo, N. Y	May	8
Cultivator-teeth	David B. Rogers	Pittsburg, Pa	May	8
Cultivators	John Neff, jr	Pultney, N. Y	May	8
Cattle, breachy, Apparatus for	John P. Ledy and Wm. Boyers.	Mount Carroll, Ill	May	15
Corn-shellers	J. G. Putnam, assignor to self and J. Schiefflein, jr.	Tioga, Pa	May	22
Cultivators, Hand	David C. Jordon	Centre Port, N. Y	May	22
Cultivators	R. P. Van Horne	Gratiot, Ohio	May	29
Churn	J. W. Evans	Forsyth, Ga	May	29
Churn	D. M. Woodin	Brandon, Wis.	May	29
Corn-shellers	E. A. Smead	Tioga, Pa	June	5
Churn	Nathan D. Ross	Braintrim, Pa	June	5
Cultivators	Vines Harwell	Walker county, Ga	June	5
Cultivators, Cotton	W. F. Johnson	Wetumpka, Ala	June	5
Churn	Otis W. Stanford	Cincinnati, Ohio	June	12
Churn	Harry Abbot	North Huron, N. Y	June	19
Cultivator-teeth	Charles H. Sayre	Utica, N. Y	June	19
Churn	Samuel A. Kerr	Arbor Hill, Va	June	19
Corn-shellers	J. P. Smith	Hummelstown, Pa	June	19
Churns	Clark Wright and Wm. Phelps.	Sycamore, Ill	June	19
Corn-huskers	David M. Mefford	Jeffersonville, Ind	June	26
Cultivators	Thos. and Robert Kinghorn	Morgan, Ohio	June	26
Cultivators	John M. Williams	Greenville, Ga	June	26
Cultivators	O. F. Fitch	Morristown, Ind	June	26
Cultivators	Joshua F. Cameron	Livingston county, Mo	June	26
Cultivators	R. M. Brooks	Greenville, Ga	June	26
Cotton-scrapers	James M. Cobb	Jackson, Tenn	June	26
Cultivators	James Charlton	Allegheny, Pa	June	26
Cultivator-teeth	Josiah Turner and Thomas P. Smith, assignors to selves and Edmund Burke.	Sunapee, Conn	June	26
Cultivators	Council Clark	Andersonville, Ga	July	3
Cotton-pickers	John Griffin	Louisville, Ky	July	3
Churn	N. B. Cooper	Gratis, Ohio	July	3
Cultivators, Cotton	Richard J. Gatling	Indianapolis, Ind	July	3
Churn	Levi Bissell	North Bergen, N. Y	July	10
Cultivators	Harrison Ogborn	Greenfork, Ind	July	10
Cultivators, Cotton	J. Hinman and D. S. French, assignors to themselves and N. King.	Watertown, &c., Mass	July	10
Cultivators	Allan Agnew and Wm. Morrisson.	Chester county, &c., Pa.	July	10
Cultivators	J. B. Livezey	Clarksboro', N. J	July	10
Cultivators, Cotton	M. Rigell and W. D. Ivey	Dawson, &c., Ga	July	17
Corn-shellers	T. J. Newland	Wolcott, Vt	July	17
Cultivators, Cotton	Thomas H. Dodge	Washington, D. C	July	17
Cultivators	Ephraim Briggs	Medina, Ohio	July	17
Cultivators, Cotton	Jacob A. Hartsfield	Kinston, N. C	July	17
Churn	John Paff	Eden, N. Y	July	17
Cultivators, Cotton	G. W. N. Yost	Yellow Springs, Ohio	July	17

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.	
Corn-stalks, Machine for shocking	S. B. Lawrence	Hookstown, Pa	July	24
Cotton-pickers	Lewis Jennings, assignor to self and R. Dickinson.	Brooklyn, N. Y	July	31
Churns	D. Sherman and R. Fenwick, assignors to D. Sherman and B. Mills.	Union Town, Md	July	31
Churn	John Park	Joliat, Ill	July	31
"Cribbing," Device to prevent horses from.	W. H. Bishop and A. H. Low.	Warren, Mass	July	31
Cultivators	Ezra Emmert	Franklin Grove, Ill	July	31
Cultivators	Z. W. and E. D. Lee	Blakely, Ga	July	31
Cultivators	W. C. Lostutter and S. Wolcott	Rising Sun, Ind	July	31
Cultivators, Cotton	Jesse Speer	Hazlehurst, Miss	July	31
Cultivators, Cotton	James L. Middlebrooks	Salem, Ga	July	31
Churn	John M. Buell	Zanesville, Ohio	August	7
Cutting-boxes	C. Sewerkrop	Louisville, Ky	August	7
Cultivators	Schuyler Goldsmith	Wataga, Ill	August	14
Churn	S. Hutchings and J. D. Leach.	Penobscot, Me	August	14
Cultivators	Lyman E. Hawkins	Sangamon, Ill	August	14
Cultivators	Jackson Shannon	Dakota, Wis	August	14
Cultivators	Ferdinand Wolf	Brooklyn, N. Y	August	14
Cultivators	Mark Rigell	Dawson, Ga	August	14
Cultivators	W. A. Taylor and W. W. Graves	Fort Adams, Miss	August	14
Corn-stalk cutters	J. R. Marshall	Marine, Ill	August	21
Corn-shellers	Geo. Danforth	Friendsville, Ill	August	21
Cultivators	Lewis Leber	Springfield, Ohio	August	21
Cultivators	T. W. McDill	Oquawka, Ill	August	21
Cultivators	Thomas Black	Princeville, Ill	August	28
Cultivators	Ephraim Wells	Auburn, Miss	August	28
Cattle-ties	George Hull	Port Crane, N. Y	August	28
Cane-coverers	E. H. Angamar, assignor to self and Tobias Marcus.	New Orleans, La	August	28
Cultivators	George W. Brown	Galesburg	August	28
Cultivators	Enoch S. Huff	Zanesville, Ohio	August	28
Cultivators	G. W. N. Yost, assignor to self and John F. Watson.	Yellow Springs, Ohio	August	28
Corn-shellers	Michael Houseman	Huntington, Ind	September	4
Cultivators	G. R. Gilbert and S. R. Weston	Starkville, &c., Ga	September	4
Cultivators, Cotton	W. W. Golsan	Autaugaville, Ala	September	4
Cultivators	G. W. N. Yost	Yellow Springs, Ohio	September	4
Cotton-scrapers	James C. Teague	Centre Hill, Miss	September	4
Cultivators	W. H. and L. Seymour	Weymouth, Ohio	September	11
Cheese-vats	William Ralph	Holland Patent, N. Y	September	25
Cultivators	John F. Wood	Houma, La	September	25
Cultivators	T. E. C. Brinly	Louisville, Ky	September	25
Corn shellers and cleaners	J. C. Richards, assignor to self, J. Hubler, and R. M. McGrath.	Lafayette, Ind	September	25
Cultivators, Cotton	J. C. Sellers	Woodville, Miss	September	25
Cows, stabling	Patrick Burke	Helena, N. Y	October	9
Cultivators	Cyrus Debolt	Ottawa, Ill	October	9
Cultivators	N. C. Carter	Union City, Ind	October	9
Churn	William W. Reid	Rochester, N. Y	October	16
Churn	John W. Helberg	Pittsburg, Pa	October	16

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Corn-shellers	George W. Hathaway	Tioga, Pa	October 16
Cultivators	William May, assignor to self and Jerome de Bruin.	Winchester, Ohio	October 16
Churn-dasher	John J. Watson	Buffalo, N. Y	October 16
Churn-dashers, Fastening blades of	Salem T. Lamb	New Washington, Ind	October 16
Cultivators	H. H. Robertson and C. G. Carr	Kingston, Mo	November 6
Cotton-seed, Machine for cleaning	A. J. Hardin	Shelby, N. C	November 6
Cotton and corn-stalk cutters	George S. Rondebush	Natchez, Miss	November 13
Cheese, Manufacture of	William McAlister	Gerry, N. Y	November 13
Churns	H. A. Nevers and C. Ross	Claremont, N. H	November 20
Cultivators, cotton	Henry G. Street	Liberty, Miss	November 27
Cultivators	L. Stevens	Dover, Ky	November 27
Cultivators	J. Neidisch and E. R. Girvin	Lancaster county, Pa	November 27
Cultivators	Nelson Messenger	Newark, Ill	November 27
Cotton-scrapers	J. W. Collins and R. Y. Wilkinson.	Clinton, La	November 27
Cultivators	J. H. and E. H. Anderson	Easton, Md	November 27
Cultivators	Luther B. Benton	Penn Yan, N. Y	November 27
Cultivators	C. A. Clark	Bloomfield, Iowa	November 27
Cotton-scrapers	C. H. Burbidge	Middletown, Conn	November 27
Carts, water	Haines Austin	East Liberty, Ohio	November 27
Cultivators	Hiram J. Lake	Conquest, N. Y	November 27
Cotton-scrapers	William L. Melholen	Centre, Ala	November 27
Cultivators	M. H. Moore and A. Satterwhite	Rome, Ga	November 27
Cultivators	Harrison C. Ravenscraft	Kingwood, Va	November 27
Cultivators	William J. McCoy	Centreville, Ga	November 27
Cultivators, Cotton	Noah Rogers	Thomas county, Ga	November 27
Corn, Husking and shelling	John Wind, assignor to self and T. G. Bottoms.	Thomasville, Ga	December 4
Cultivators	H. M. Bilden	Farmington, Ohio	December 4
Cultivators, Cotton	N. A. H. Goddin	Wilson, N. C	December 4
Cultivator, Seeding	Thomas A. Galt	Sterling, Ill	December 11
Cultivators	Benjamin Tinkham	Cameron, Ill	December 11
Cultivators	Isaac Miers	Clay Lick, Ohio	December 18
Churn	D. T. Ward	Mansfield, Ohio	December 18
Churn	John Pike	Syracuse, N. Y	December 18
Cultivators	J. B. Geisinger and D. H. S. Williams.	Montville, Ohio	December 18
Cultivators	Joseph and St. Clair Gum	Marseilles, Ill	December 18
Cotton-cleaner	Charles Smith	Knoxville, Tenn	September 11
Cotton-cleaners	Isaac Hayden	Lawrence Mass	September 11
Cotton-cleaners	S. C. Ames	Washington, Ark	September 11
Corn-husks, Machine for stemming	David M. Mefford	Jeffersonville, Ind	October 2
Cotton-cleaners	William H. Johnson	Richmond, Ark	October 2
Cotton-cleaners	Joseph W. Thorn	Courtland, Ala	October 16
Cotton-cleaning machines	B. Jackman	Louisville, Ky	December 11
Cotton-cleaners	J. Ryder, W. Carpenter, and H. R. Jolly.	Clinton, La	December 18
Cane-juice, Apparatus for applying sulphurous acid gas in purification of	Jean Communcy	New Orleans, La	December 11
Crushing-apparatus, Sugar	Adolph and Felix Brown	New York, N. Y	March 27
Crushing sugar-cane, Machine for	Theodore Grundman	Freeport, Ill	April 17
Crushers, Corn and Cob	Amos Glover	Powhattan Point, Ohio	June 5

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Cleaning rice, Machine for	James Van Valkinburgh......	Binghamton, N. Y.	August 21
Cleaning buckwheat, &c., Machine for.	John H. Reed, assignor to self and L. J. Crans.	Penn Township, Pa...	September 4
Coffee, Apparatus for cleaning, drying, and polishing.	William Newell	Philadelphia, Pa.	September 18
Cleaning rice, Machine for	Silas Dodson	San Francisco, Cal.....	September 25
Cleaning rice, Machine for	Simon P. Kase...............	Danville, Pa...........	November 20
Drills, Seed......	Jonathan Smith..............	Tiffin City, Ohio.......	February 14
Drills, Seed.........................	James Selby.................	Peoria, Ill.	March 6
Drill, Hand	J. H. Parker, assignor to E. H. Ashcroft.	Boston, Mass	May 15
Drill, Hand..........................	J. H. Parker, assignor to E. H. Ashcroft.	Boston, Mass	May 15
Digging-machine.....................	Andrew A. Garver...........	Mechanicsburg, Pa.....	May 22
Drills, Seed.........................	G. S. Ball and Wm. H. Nauman.	Dayton, Ohio...........	September 25
Drills, Seed.........................	Hiram Moore	Brandon, Wis..........	November 20
Drills, Seed.........................	Anton Smith.................	Girard, Ill.	November 27
Defecating cane-juices...............	D. F. Boyd	Mansfield, Ohio........	February 7
Defecating cane-juice, Apparatus for .	E. H. Wheeler...............	New Orleans, La.......	May 8
Ditching-machines	Austin Woodfolk	Parish of Iberville, La..	March 6
Ditching-machines	John W. Barcroft	Friendship, Va.........	March 13
Drain-tile, Mode of laying..........	Henry F. Baker..............	Centreville, Ind........	May 1
Ditching-machines	C. O. West, J. R. Smith and others.	Martinsville, Ohio......	May 15
Ditching-machine...................	Isaac A. Benedict and G. W. Cummings.	West Springfield, Pa...	May 15
Ditching-machine....................	John Masters................	Waukegan, Ill.........	May 22
Ditching-machine....................	P. W. Adaire................	Hay's Creek, Miss......	June 5
Ditching-ploughs, Capstans for.......	Elias Forbis	London, Ohio..........	July 24
Ditching-machine, Mole..............	Isaiah Hodgson..............	New Michigan, Livingston county, Ill.	July 24
Ditching-machine....................	Allen S. Ballard, assignor to self and Joseph Howe.	Mt. Pleasant, Iowa.....	August 14
Dams, Mill, self-acting waste-gate for.	Sidney Hudson	Milford, Mich..........	September 4
Evaporating saccharine juices, Apparatus for	John Souther................	Boston, Mass	January 10
Evaporating saccharine juices, Apparatus for	D. B. Neal and H. C. Emery, assignors to themselves and George E. House.	Mt. Gilead, Ohio	February 21
Evaporating saccharine juices, Apparatus for	Samuel H. Gilman...........	New Orleans, La.......	February 21
Evaporation of cane-juices	Richard Wright	Great Britain	October 16
Elevators for hay, &c............. ..	F. F. Fowler	Crane Township, Ohio..	April 17
Elevators, hay	Wm. C. Durkee, assignor to self and A. S. Williams and Jos. H. Hopkins.	Fort Edward, N. Y.....	June 12
Elevating, cleaning, and bagging grain, Machine for	Ira A. Stafford...............	Essex, N. Y.	October 23
Fruit-gatherers	David P. Chamberlin.........	Hudson, Mich	January 3
Flower-pots	John Hively	Dayton, Ohio..........	January 17
Fertilizers, Machine for sowing......	William D. Mason......... .	Jarrett's Depot, Va	April 3
Fodder, Machine for cutting	P. S. Clinger	Conestoga Centre, Pa ..	August 14
Fodder-cutters......................	Adam R. Reese..............	Phillipsburg, N. J	November 20
Feed-cutters........................	George W. Hathaway........	Tioga, Pa	December 4

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Fertilizers, Machine for sowing	B. Picquet	Augusta, Ga	December 11
Fibrous materials, Method of reducing long staple.	Stephen M. Allen	Niagara Falls, N. Y	April 17
Fibrous materials, Surfacing	William Fuzzard	Charlestown, Mass	June 19
Fertilizers	Lewis Harper	Riceville, N. J	January 31
Fertilizers	Auguste Rolland	France	February 27
Fertilizers	Samuel Stephens	Philadelphia, Pa	May 29
Fences	Sylvester Denton	Penn Yan, N. Y	February 21
Fence, Machine for making picket	James Moore and Archibald Kelly.	Pittsburg, Pa	April 17
Felling trees	Pomeroy Johnson	Whitney's Point, N. Y.	May 15
Fence-rails, Machine for pointing	Christian Yost	Intercourse, Pa	July 3
Fences, Portable	William M. Wallace	Cameron, Ill	July 3
Felling trees, Machine for	A. P. Torrence	Oxford, Ga	July 3
Fences	Henry Burrows, assignor to self and E. W. Woodruff.	Georgetown, D. C	September 11
Fences	Nathaniel M. Stratton	New York, N. Y	October 23
Fences	J. M. Pitts	Sumter, S. C	October 30
Fences, Flood	David C. Wilkinson	Sidney, Ohio	November 6
Fences	O. H. Woodworth	Upper Marlborough, Md.	November 27
Gins, Cotton	Barton H. Jenks and Wm. A. Tuttle.	Philadelphia, Pa	January 3
Gins, Cotton	Lewis S. Chichester, assignor to H. G. Evans.	New York, N. Y	January 10
Gins, Cotton	W. W. Howell	Columbus, Miss	February 28
Gins, Cotton	A. H. Burdine	Chulahoma, Miss	August 28
Gins, Cotton	John Goulding	North Wilbraham, Mass.	August 28
Gins, Cotton	Horace L. Emery	Albany, N. Y	September 4
Gins, cotton, Feeder for	S. Z. Hall	Seguin, Texas	September 11
Gins, Cotton	N. A. Patterson	Kingston, Tenn	October 23
Grain-binding machines	Daniel W. Ayres	Middleport, Ill	May 22
Grain-binders	Hermann Kaller	Perry, Ill	June 5
Grain-binders	W. W. Burson	Yates City, Ill	June 26
Grain, Machine for binding	Thomas Courser	Princeton, Ill	July 10
Grain-binders	J. S. Hickey	Pike, Ill	July 17
Grain-cradles	Elijah D. Wilcox, assignor to self and G. D. Nourse.	Bellingham, Mass	July 24
Grain-separator	Thomas Earheart	Donelson, Tenn	July 24
Grain-separator	Andrew J. Vandegrift	St. Louis, Mo	July 24
Grain, Machine for threshing and cleaning.	Ira Hart	Clarksburg, Va	July 31
Grain-separators	Cornelius Bergen	Farmer, N. Y	July 31
Grubbing-machines	Jacob B. Ash	Elkton, Md	August 21
Grain-elevators	T. H. Green	Fond du Lac, Wis	September 4
Grafting-machines	James W. Crawford	Rockport, Ind	November 13
Grain-riddles	Anson Rowe	Atalissa, Iowa	December 4
Grinding apples, Machine for	Isaac T. Carpenter	Martin's Ferry, Ohio	January 24
Grain-fans	George Goervey	Philadelphia, Pa	January 10
Grain-fans	Peter Bailey	Falls Township, Bucks county, Pa.	March 13
Grain-cleaners	Abram Gaar, assignor to self, John M. Gaar and W. G. Scott.	Richmond, Ind	March 13
Grain-cleaners	George W. Osborn	Centreville, Mich	March 13

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.	
Grain-cleaners	A. T. Waldo	Dryden, N. Y	March	13
Grain-cleaners	Philip C. Fritz	Barrytown, N. Y	May	1
Grain-cleaners	William B. Webster	Foxville, Va	May	1
Grain when fed to the mill and cooling the millstones, Machine for	William H. Akens and D. Babcock.	Dryden, N. Y	June	12
Grain-scouring and separating machine.	Matthew Bartholomew	Enterprise, Lancaster county, Pa.	July	24
Grain-cleaning machines	John P. Tunison	Ovid, N. Y	September	18
Grain, Machine for cleaning	John Outram	Elmira, N. Y	October	30
Grain-cleaning machines	Wm. Crotzer, assignor to self and Samuel Beamer.	Spruce Creek, Pa	November	20
Grain, Machine for cleaning	R. C. Mauck	Harrisonburg, Va	December	18
Hop-frames	Levi A. Beardsley	South Edmeston, N. Y.	January	10
Harrows	John Russel	Grampian Hills, Pa	January	17
Hay or Straw-cutters	Sylvanus S. Clark	Manchester, N. H	January	17
Harvesters	J. Scoville	Buffalo, N. Y	January	31
Harvesters	Peter Flickinger	Hanover, Pa	February	14
Harvesters	Samuel and John H. Buser	Warren, Ill	February	14
Harvesters	E. Peck	San José, Cal	February	14
Harrows	N. A. Patterson	Kingston, Tenn	February	14
Harvesters	Charles B. Withington	Rock, Wis	February	21
Harvesters	William A. Vertrees	Winchester, Mo	February	28
Harvesters, Corn	H. Gortner and J. McCann	Nashporte, Ohio	March	6
Harvesters, Corn and Cane	D. P. Flinn and R. S. Hayes	Leroy, N. Y	March	6
Hoes	Huntington Porter	Cummington, Mass	March	6
Harrows	Silas C. Schofield	Freeport, Ill	March	13
Harvesters	E. Ball and M. L. Ballard, assignors to E. Ball.	Canton, Ohio	March	20
Harvesters, Guard-fingers for	Robert Beans	Johnsville, Pa	March	20
Harvesters	David Van Kleeck	Coshocton, N. Y	March	20
Harrows, Seeding	Henry Hervett, assignor to W. A. Sanford.	San Francisco, Cal	March	27
Harvesters	Pells Manny	Waddam's Grove, Ill	March	27
Harvesters	Geo. E. Chenoweth	Baltimore, Md	March	27
Harvesters	Edwin Jones	Chester Cross Roads, O.	March	27
Harvesters, Cutting-apparatus for	Geo. Fetter, assignor to self and Jones & Comley.	Philadelphia, Pa	April	3
Harvesters, Corn	Adam Humberger	Somerset, Ohio	April	3
Hoes, Garden	John R. Albertson	East Deer Township, Pa.	April	3
Harvesters	Lewis C. Reese	Phillipsburg, N. Y	April	10
Harvesters	Jacob L. Paxson	Norristown, Pa	April	10
Harvesting-machines	Bennet F. Witt	Dublin, Ind	April	10
Harrows, Seeding	William Finley	Schoolcraft, Mich	April	10
Harvesting-machine	Martin Hallenbeck	Albany, N. Y	April	17
Harvesters, Rakes for	Worden P. Penn	Belleville, Ill	April	24
Harvesters	A. and N. Kane	Newport, N. Y	April	24
Harvesters	S. Y. Bruce	Marshall, Mo	May	1
Harvesters, Making guard-fingers for	George W. Slough, assignor to E. Ball.	Canton, Ohio	May	8
Harvesters, Automatic raking-apparatus for	Wm. H. Wilson	Denton, Md	May	8
Harvesters	A. Stohler and Sam'l A. Sisson	Bristol, Pa	May	15
Harvesters	William A. Kirby	Buffalo, N. Y	May	15
Harrows, Seeding	Marshall S. Root	Medina, Ohio	May	22

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Harvesting machines	J. A. Wagener	Pultney, N. Y.	May 22
Harvesters	Robert Bryson	Schenectady, N. Y.	June 5
Harvesters	Joseph Woodruff	Rahway, N. J	June 5
Harvesting-machines	Benaiah Titcomb	Baltimore, Md	June 5
Harvesters, Raking and binding-apparatus for	A. B. Smith	Clinton, Pa	June 19
Harvesters	Samuel and J. H. Barley	Longwood, Mo	June 19
Harvesters, Automatic rakes for	John Ollis	Bloomington, Ill.	June 26
Hay, Loading	Thomas J. Jolly	Olean, Ind	June 26
Hay, Unloading	H. H. Angell	Clermont, Iowa	June 26
Hay, Loading	William Dixon	Chicago, Ill	June 26
Harvesters, Raking-attachment for	Daniel Guptail	Elgin, Ill	June 26
Harrows	Stephen A. and Curtiss C. Morgan.	Auburn, N. Y.	June 26
Harrows	Daniel C. Colby, assignor to self and Jas. P. Upham.	Newport, N. H	June 26
Harvesting-machines	William Wilmington	Toledo, Ohio	July 3
Harrows	Leroy C. Gillaspie	Denmark, Tenn.	July 10
Harvesters	Benj. A. Jenkins	White Water, Wis	July 10
Harvesters of corn and sugar-cane	G. W. N. Yost, assignor to G. W. N. Yost & Co.	Cincinnati, Ohio	July 10
Harvesting-machines	John M. Bowman, assignor to Huntley, Bowman & Co.	Brockport, N. Y.	July 10
Harvesting-machines	John H. Rible, assignor to Jacob W. Bope.	Somerset, Ohio	July 10
Harvesters	Cornelius R. Brinckherhoff	Batavia, N. Y	July 10
Hay-racks for carts	Horace R. Hawkins	Akron, Ohio	July 10
Hullers, Cotton-seed	P. Martin	New Orleans, La	July 31
Hay, Teeth for scattering	J. C. Stoddard	Worcester, Mass	July 24
Harvesting-machines	James H. Maydole	Eaton, N. Y.	August 7
Harvesters, Grain	Charles Marston	Viroqua, Wis	August 14
Harvesters, Automatic rakes for	Isaac C. Twining	Wrightstown, Pa	August 14
Harvesters	W. S. Stetson	Baltimore, Md	August 14
Harvesters	George Farmer	Osceola, Ill	August 21
Harvesters	John H. Irwin	Beardstown, Ill	August 21
Harrows	M. D. Meriwether	Denmark, Tenn	August 28
Harvesters	Frederick H. Manny	Rockford, Ill	August 28
Hay and straw-cutters	David H. Whittemore	Lynchburg, Va	September 4
Harrows	Mark W. House	Cleveland, Ohio	September 4
Harvesters	John M. Long, assignor to self, Peter Black and R. Alsatta.	Hamilton, Ohio	September 4
Harrows	Stewart Neill	Chilicothe, Ohio	September 4
Harvester cutters	Benjamin T. Roney	Philadelphia, Pa	September 11
Harvesters, Raking attachment for	C. P. Gronberg	Aurora, Ill	September 11
Hay elevating fork	L. A. Beardsley	South Edmeston, N. Y.	September 11
Harvesters, Raking apparatus for	W. A. Wood	Hoosick Falls, N. Y	September 11
Harvesting-machines	Bernhard Mertz	Burlington, Iowa	September 11
Harvesters, Combined rake and reel for	McClintock Young, jr	Frederick, Md	September 18
Hay and Straw-cutters	Jacob D. Felthausen	Michigan City, Ind	September 18
Harvesters	Henry H. Foye	Ottawa, Ill	September 25
Harvesters	Thomas N. Foster	Watertown, N. Y	October 2
Harvesters	Frederick H. Manny	Rockford, Ill	October 2
Harvesting-machines, Cutting apparatus of	Salem T. Lamb	New Washington, Ind	October 2

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Harvesters, Sugar-cane	W. F. Johnson and J. Doyle	Philadelphia, Pa	October 2
Harrows	C. Watson, assignor to self and A. H. Tinsley.	Cascade, Va	October 2
Harrows, Rotary	Jehu Brainerd	Cleveland, Ohio	October 2
Harvesting-machines	Salem T. Lamb	New Washington, Ind	October 9
Harvesters, Cane	Achilles St. Dizier	Plaquemine, La	October 9
Harrows, Rotary	Sidney S. Hogle	Cleveland, Ohio	October 30
Hay, &c., Machines for cutting	T. H. & D. T. Willson	Harrisburg, Pa	November 6
Harvesters, Cutting-apparatus of	William G. Smith	Elizabethport, N. J	November 6
Harvesters	Nathan Maxson	Wilmington, Ohio	November 13
Harvesters	Frederick Landon, assignor to Byron E. Huntley, John M. Bowman, and Charles and Lafayette Silliman.	Brockport, N. Y	November 13
Harvesters	Samuel W. Tyler	Greenwich, N. Y	November 13
Harvesters	L. D. Brown	St. Louis, Mo	November 20
Hay and Straw-cutters	Horace R. Hawkins	Akron, Ohio	November 20
Harrows, Rotary	Francis Raymond	Sandusky, Ohio	November 27
Harrows, Rotary	P. Gevin and Eli Foreman	Summerville, Pa	November 27
Harrows, Cultivating	Joseph Slocum	Syracuse, N. Y	November 27
Harrows	James Temple, assignor to Joseph Keyser.	Bellefonte, Pa	November 27
Hay and Straw-cutters	J. N. Neff	Strasburg, Pa	November 27
Harvesters, Rake for	Adam Pritz	Dayton, Ohio	December 4
Harrows, Rotary	Michael L. Bauder	Cleveland, Ohio	December 4
Harvesters, Cotton	Wm. Apperly & C. P. Johnson.	Memphis, Tenn	December 11
Harvesters, Rakes for	Stephen A. Lindsay	Unionville, Md	December 11
Hogs from rooting, Device for preventing.	D. K. Nixon	Sandyville, Ohio	December 18
Harvesting-machines, Rakes for	Lewis P. Brady	Mount Joy, Pa	December 18
Harvesting-machines	John S. Royce	Cuylerville, N. Y	December 18
Harrows	John Allen	Union, N. Y	December 18
Harvesting-machines	McClintock Young, jr	Frederick, Md	December 18
Harvesters	John Blue	Covert, N. Y	December 18
Hemp-brakes	John Mills, jr	Quincy, Ill	May 29
Hemp-brake	E. W. Lacy	Oak Park, Va	July 31
Hemp-brake	Richard J. Gatling	Indianapolis, Ind	September 4
Hemp-brakes	Ives Scoville	Chicago, Ill	September 25
Hemp-brakes	Ezekiel Guile	Waverly, Mo	October 16
Hominy-machines	John Gehr	Clear Springs, Md	July 17
Hulling and polishing rice, Machine for	Chase B. Horton	Elmira, N. Y	August 28
Hullers, Rice	D. Greene, assignor to self and J. H. W. Page.	Boston, Mass	November 6
Hulling and cleaning rice, Machine for	Horatio N. Black, assignor to self, H. Korn, jr., and E. S. Bodine.	Philadelphia, Pa	November 13
Hulling clover-seed, Machine for	M. F. Noraconk & D. Hoats	Milton, Pa	December 18
Hulling Clover	Joseph D. Forry	Lewistown, Pa	December 18
Hulling and finishing rice, Machine for	Robert Anderson	Brooklyn, N. Y	February 21
Hullers, Rice and clover	Stephen Burrows	White Water, Wis	May 8
Hullers, Rice	J. Moore Hendricks	Philadelphia, Pa	May 29
Hulling cotton-seed, Machine for	Joel Tiffany	Syracuse, N. Y	September 18
Hulling-machine, Rice	Daniel Lombard	Boston, Mass	October 23

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Mowing-machines	O. R. Chaplin, assignor to self and O. G. Hale.	St. Johnsbury, Vt	January 10
Mowing and reaping machines	John Butler	Buffalo, N. Y	February 7
Mowing-machine cutters	Fisk Russell	Manchester, N. H	February 14
Mowing and reaping machines	Vosco M. Chafee	Xenia, Ill	March 20
Mowing-machines	Sam'l Ray and M. R. Shalters, assignors to Fisher, Shalters & Co.	Alliance, Ohio	April 10
Mowing-machines	A. M. George	Nashua, N. H	May 1
Mowing and reaping machines	Richard Ketcham	South Dansville, N. Y	May 15
Milkers, Cow	L. O. Colvin	Cincinnatus, N. Y	May 22
Milkers, Cow	L. O. Colvin	Cincinnatus, N. Y	May 29
Mowing-machines	Chester Bullock, assignor to self and De Forest Weld.	Jamestown, N. Y	June 5
Mowing-machines	Anthony B. Allen	New York, N. Y	July 24
Mowing-machines	James W. Shipman	Springfield Centre, Otsego county, N. Y.	July 24
Mowing-machines	Frederick Gardiner	Gardiner, Me	July 31
Mowing-machines	Frederick W. Warner	East Haddam, Conn	July 31
Mowing-machines	Henry Marcellus	Amsterdam, N. Y	September 4
Mowing-machines, Hand	John M. Spencer	Enfield, Me	September 4
Mowing and reaping machines, Driver's seats for	Franklin Getz	Amherst, N. Y	November 6
Mowing-machines	John G. Dunham	Raritan, N. Y	December 18
Mills, Cider	R. M. Curtice	North Adams, Mich	January 10
Mills, Flour	James M. Clark	Philadelphia, Pa	January 10
Mills, Coffee	John and Edmund Parker	Meriden, Conn	February 7
Mills, Grain	John W. Wheeler, assignor to Charles W. Williams and James E. Wheeler.	Cleveland, Ohio	February 21
Mills, Cider	E. H. Philo, assignor to Chas. E. Pease.	Halfmoon, N. Y	March 27
Mills, Sugar, Crushing rollers for	Philetus W. Gates, assignor to self, Thomas Chalmers and D. R. Fraser.	Chicago, Ill	April 10
Mills, Sugar	George W. L. Hazen	Indianapolis, Ind	April 17
Mills, Hominy	John D. Heatwole and R. C. Mauch.	Harrisonburg, Va	May 1
Mills, Corn and cob	Stephen A. Briggs, assignor to self and C. G. Crowell.	Philadelphia, Pa	July 3
Mill for grinding grain and apples	Charles B. Hutchinson	Auburn, N. Y	August 7
Mills for cutting and grinding the corn cob and husk together.	Evarist Mire	New Orleans, La	August 7
Mills, Sugar-cane	Hugh T. Douglass	Zanesville, Ohio	August 28
Mills, Feeding grain to	M. H. Ferguson	Sunfish, Ohio	September 11
Mill for grinding coffee	Lewis S. Chicester	New York, N. Y	October 9
Planters, Corn	John Gross	Decatur, Ill	January 3
Planters, Corn	Alexander Anable	Middlesex, N. Y	January 3
Planters, Corn	Daniel Nichols	Orange, Ill	January 3
Ploughs	Henry F. Cromwell	Cynthiana, Ky	January 3
Ploughs	J. V. Taylor	Dixon, Ill	January 3
Planters, Corn	Joseph J. Knight, assignor to self, Thos. Patterson and James Lydell.	Philadelphia, Pa	January 10

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Ploughs	Vosco M. Chafee	Xenia, Ill	January 17
Ploughs	Joseph L. Dutton, jr	Cherry Lake, Fla	January 31
Planters, Hand seed	Francis Van Doren	Adrian, Mich	February 14
Ploughs	Robert H. Brooks	Greenville, Ga	February 14
Ploughs	Elijah B. Clark	Tallahassee, Fla	February 14
Planters, Cotton-seed	L. Acree	——— Taliaferro co., Ga.	February 14
Planters, Cotton-seed	Abner Carey	Rome, Ga	February 14
Ploughs	Wm. H. Johnson, assignor to self and J. B. Ballah.	Richmond, Ark	February 14
Ploughs, Steam	George W. Ramsay	New York, N. Y	February 21
Planters, Seed	John S. Huggins	Timmansville, S. C	February 28
Ploughs	Silas O. Vaughan	De Kalb, Ill	February 28
Planters, Seed	N. R. Carrington	Cold Water, Miss	March 6
Planters, Corn	William M. Garee	Grandville, Ohio	March 6
Planters, Hand corn	Heman B. Hammon	Bristolville, Ohio	March 6
Ploughs, Shovel	Joshua T. Cameron	Livingston, Mo	March 6
Planters, Cotton-seed	Curran Battle	Warrenton, Ga	March 13
Prunning instruments	John Fasig	Congress, Ohio	March 13
Plough	William Watson	Bishopville, S. C	March 13
Ploughs	William R. Saunders	Buena Vista, Miss	March 27
Planters, Seed	Thomas B. McConaughey	Newark, Del	March 27
Ploughs	George W. Hunt	Muscatine, Iowa	March 27
Ploughs, Subsoil	Ezekiel Gross	Goshen Hill, S. C	March 27
Ploughs	Baldwin Davis and J. M. Scroggins.	La Grange, Ga	March 27
Planters, Cotton-seed	Samuel P. Sweeney	Columbia, Texas	April 3
Planters, Corn	Geo. W. N. Yost, assignor to G. W. N. Yost & Co.	Yellow Springs, Ohio	April 3
Ploughs	D. H. & E. E. Smith	Glenn Springs, S. C	April 3
Ploughs, Seeding	C. Atkinson	Vermont, Ill	April 10
Planters, Corn	Martin A. Howell, jr	Ottawa, Ill	April 10
Ploughs	William D. Ivey	Milford, Ga	April 10
Planters, Seed	John Robinson, of Eli	Sharptown, Md	April 17
Ploughs, Seeding	James Peeler	Tallahassee, Fla	April 24
Ploughs, Cotton-thinning	L. B. Joyner	Hilliardson, N. C	April 24
Ploughs	Matthew C. McCullers	Herndon, Ga	April 24
Plough-stock	John A. Byrd	Marianna, Fla	May 1
Planters, Corn	Amos Seaman	Rockford, Ill	May 1
Planters, Corn	William C. Banks	Como Depot, Miss	May 1
Planters, Corn	William C. Banks	Como Depot, Miss	May 1
Planters, Cotton-seed	N. E. Badgley	Gadsden, Miss	May 1
Ploughs	J. H. Gooch	Oxford, N. C	May 8
Potato-diggers	Elijah Robertson	Hartford, Conn	May 8
Potato-diggers	John Bawden, assignor to Gilbert Combs.	Freehold, N. J	May 8
Ploughs	John S. Willson	Waynesboro', Ga	May 8
Ploughs	Dudley Wood and A. Byington.	Byron, Ill	May 15
Planters, Seed	Ephraim Russell, assignor to self and James S. Wiley.	Coatsville, Pa	May 15
Potato-diggers	David Niven	Rochester, N. Y	May 15
Planters, Seed	W. C. Pitts	Austin, Texas	May 15
Ploughs	W. C. Pitts, assignor to Wm. A. Pitts.	Austin, Texas	May 15
Ploughs	Isaac N. Rankin	Middletown, Iowa	May 22

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.	
Ploughs, Spade	Elijah Harris	Princeton, Ill	May	22
Planters, Seed	John W. Masten	Utica, Mich	May	22
Planters, Corn	Joel Lee	Galesburg, Ill	May	22
Planters, Corn	Abiel Hays and Jas. Vancuren.	Chenoa, Ill	May	22
Ploughs, Clevis for	Calvin Adams	Pittsburg, Pa	May	22
Ploughs, Clevis for	John S. Huggins	Timminsville, S. C.	May	22
Potato-diggers	Carolus Dunham	Batavia, Mich	May	22
Planters, Corn	J. H. Bonham	Elizabethtown, Ohio	May	22
Ploughs	C. J. Shiver	Camden, S. C	May	22
Planters, Corn	B. F. Stowell	Quincy, Ill	May	22
Ploughs	M. G. Rhodes and J. M. Skaggs.	Talledega, Ala	May	22
Planters, Corn	John Johnson	Naples, Ill	May	29
Planters, Corn	J. Campbell Moore	Peoria, Ill	May	29
Ploughs, Cultivating	Allen Hughes	Gratiot, Ohio	May	29
Ploughs, Mould-boards for, Machine for making	Hiram H. Scoville	Syracuse, N. Y	May	29
Planters, Seed	H. C. Fairchild	Brooklyn, Pa	June	5
Planting cotton seed, Machines for	Whitman Price	Mount Olive, Wayne county, N. C.	June	5
Ploughs	Whitman Price	Mount Olive, Wayne county, N. C.	June	5
Planters, Corn	Daniel Moyer	Delaware, Pa	June	5
Planters, Corn	Ptollman Stover	West Alexandria, Ohio.	June	5
Planters, Seed	James Green	Kennett Square, Pa	June	5
Ploughs	C. F. Richter	Columbia, S. C	June	5
Ploughs	H. A. G. Pomeroy and R. F. Hudson.	Providence, &c., R. I.	June	12
Planters, Corn	D. C. Myers	Richmondale, Ohio	June	12
Ploughs	Thomas R. Markillie	Winchester, Ill	June	19
Ploughs, Steam	L. B. Woolfolk	Nashville, Tenn	June	19
Planters, Seed	Alonzo J. Rogers	Stephentown, N. Y	June	19
Ploughs, Steam	Albert Bigelow	Hamilton, Upper Can.	June	19
Planters, Seed	Elijah Young	Fayetteville, Mo	June	26
Plough, Steam	L. B. Woolfolk	Nashville, Tenn	June	26
Planters, Seed	Hervey Sloan	Franklin, Ind	June	26
Planters, Cotton-seed	Benj. Owen	Dayton, Ohio	June	26
Planters, Corn	T. S. Mills	Iberia, Ohio	June	26
Planters, Corn	Davis Dutcher	Blue Grass, Iowa	June	26
Planters, Seed	David Warren	Gettysburg, Pa	June	26
Planters, Corn	R. Taylor and R. Sprague	Prairie City, Ill	June	26
Planters, Corn	Jas. L. Smith, assignor to self and J. Q. Sloan.	Neoga, Ill.	June	26
Ploughs	Jas. M. Cobb	Jackson, Tenn	June	26
Planters, Corn	Levi Morris	Woodbury, Ill	June	26
Ploughs	John T. Thompson	Jackson, Tenn	June	26
Ploughs	R. S. Williams	Bairdstown, Ga	June	26
Planters, Cotton-seed	Wm. A. & John F. Suddith.	Charlestown, Va	June	26
Ploughs	J. W. Shipp & C. W. Crenshaw	La Grange, Tenn	June	26
Ploughs	William Griffin	Bennettsville, S. C.	July	3
Ploughs, Gang	J. C. Wilson	Cedar Hill, Texas	July	3
Ploughs	Henry H. Robertson	Kingston, Mo	July	10
Planters, Corn	John Price	Harrison, Ohio	July	10
Planters, Cotton-seed	Zina Doolittle	Perry, Ga.	July	10
Planters, Seed	George Hetrich	Reidsburg, Pa	July	10

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Planters, Corn	Samuel Avery	Pisgah, Mo	July 10
Planters, Seed	G. T. Bennett	Mount Olive, N. C.	July 17
Ploughs	Elijah B. Clark	Tallahassee, Fla	July 17
Ploughs, Gang	T. S. Heptinstall	Mendota, Ill.	July 17
Ploughs	Loure Green	Great Bend, Pa	July 17
Ploughs	Matthew C. McCullers	Herndon, Ga	July 17
Potato-diggers	George C. Bartlett, assignor to D. M. Osborne & Co.	Paris, N. Y	July 24
Potato-diggers	Daniel De Garnes	Rochester, N. Y.	July 24
Potatoes, Machine for covering	Harmon L. Bennett	Long Branch, N. J.	July 31
Ploughs, Steam	Thos. H. Burridge	St. Louis, Mo	July 31
Planters, Corn	F. A. Goddard, assignor to self and John H. Kennaday.	Lexington, Ill	July 31
Planters, Corn	Christopher Smith	Nauvoo, Ill.	July 31
Ploughs	Samuel Canterberry	Holmes county, Miss.	August 14
Ploughs	J. P. Bond	Greenwood, S. C	August 14
Ploughs	Lyman D. Burch	Sherburne, N. Y.	August 14
Planters, Seed	John P. Allen	Dover, Ga	August 14
Planters, Corn	James S. Fowler	Peoria, Ill	August 14
Planters, Seed	William L. Gebby	New Richland, Ohio	August 14
Ploughs	John S. Hall	West Manchester, Pa.	August 14
Ploughs	John S. Hall	West Manchester, Pa.	August 14
Planters, Seed	Joseph F. Tannehill	Staunton, Va	August 14
Planters, Seed	William Schroeder	Laporte, Ind.	August 14
Planters, Corn	Aaron Miller, assignor to self, G. B. Whiteside, G. F. Barnett and M. Lowe.	Brockport, N. Y.	August 14
Ploughs	James Smith	Norfolk, Va.	August 14
Ploughs, Hill-side	George C. Miller and Richard Henry.	Cincinnati, Ohio	August 21
Planters, Seed	Leonard Hariman	Anderson, Ind.	August 21
Planters, Seed	Miller Warner	West Middleburg, Ohio.	August 21
Ploughs	Bancroft Woodcock	Williamsburg, Pa	August 21, antedated.
Ploughs	P. H. Starke	Richmond, Va	August 21
Planters, Corn	C. L. Waffle	Sharon, Ohio	August 21
Planters, Seed	Thomas M. Green	Milledgeville, Ga	August 21
Ploughs	A. Roden	Talladega, Ga	August 28
Planters, Corn	F. G. & E. A. Floyd	Macomb, Ill	August 28
Ploughs	J. Hardy, assignor to O. Chamberlain and W. H. Babcock.	Molini, Ill	August 28
Planters, Seed	James McLaughlin	Duncannon, Pa	August 28
Planters, Seed	James R. Mills	Bloomfield, Iowa	August 28
Planters, Corn	D. & H. Wolf	Lebanon, Pa	August 28
Ploughs	W. E. Wormele	Germantown, Tenn	August 28
Planters, Seed	W. W. Golsan	Autaugaville, Ala.	September 4
Planters, Seed	W. H. Barber	Wolcottville, Conn	September 4
Ploughs	T. E. C. Brinley	Louisville, Ky	September 4
Planters, Seed	A. F. Hines, assignor to self and B. A. Kidder.	Washington, D. C.	September 4
Planters, Cotton-seed	Oliver L. Gibson	——, Fort Bend co., Tex.	September 11
Planters, Seed	Levi F. Straight	Fairburg, Ill	September 11
Planters, Corn	Geo. W. and Jno. J. Kersey	Beartown, Pa	September 11
Planters, Potato	Edwin J. Fraser	Kansas City, Mo	September 25

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Ploughs	G. W. Cunningham	Paris, Mo	September 25
Ploughs	W. G. Savage	Clinton, Ill	September 25
Planters, Corn	John Underwood	Cameron, Ill	September 25
Ploughs	Wm. T. Zollickoffer, assignor to self and Wm. Brown.	Shelbyville, Tenn	September 25
Ploughs	Walter Warren	Penn Yan, N. Y.	September 25
Potato-diggers	John P. Scudder	Hightstown, N. J.	October 2
Ploughs	John A. Stewart	Philadelphia, Pa.	October 2
Planters, Cotton-seed	James T. Ham	Senatobia, Miss	October 9
Planters, Corn	Daniel J. and J. F. Herr	Lancaster, Pa	October 9
Planters, Seed	Wm. G. Pollock and J. W. Sener	Fredericksburg, Va	October 9
Ploughs, Securing points to	Henry D. Rogers	Grafton, Ohio	October 9
Ploughs	Matthew G. Slemmons	Cadiz, Ohio	October 9
Planters, Corn	J. W. Harbin, assignor to self and R. S. Willis.	Delaware Station, Ind.	October 16
Plough-plates from molten steel, Making	F. F. Smith	Mornence, Ill	November 20
Ploughs	Tully R. Cormick	Cap-au-Gris, Mo	November 27
Ploughs, Cotton	W. W. Graves	Fort Adams, Miss	November 27
Ploughs	Andrew Benkelman	Langford, N. Y	November 27
Ploughs	Thos. S. and Jno. A. Lockhart.	Wellington, Mo	November 27
Ploughs	John P. Pettit	Cold Springs, Ky	November 27
Ploughs	Samuel Fisher	West Windsor, N. J.	November 27
Planters, Cotton-seed	C. W. McClenahan	Victoria, Texas	November 27
Planters, Corn	W. H. Adle, P. D. Miles and G. Custer.	Morristown, Pa	November 27
Ploughs	A. W. Leland Rivers	Barnwell, S. C	November 27
Ploughs	R. G. Matheny & L. R. Barnes.	De Kalb, Miss	November 27
Ploughs, Hill-side	R. H. Ewing	Clives, Ohio	November 27
Planters, Corn	Benjamin Bower	Millersburg, Ohio	November 27
Ploughs	Everett Bass	Pachitta, Ga	December 4
Planters, Corn	W. R. Center	Athens, Ill	December 4
Ploughs	Smithwick Whitley	Tallahassee, Fla	December 4
Planters, Cotton-seed	C. H. Rose	Columbia, Ala	December 4
Ploughs	Jno. G. Robinson	Biddeford, Me.	December 4
Plough, Clevis	John S. Hall	Manchester, Pa	December 4
Planters, Corn	John H. Rankin	Versailles, Mo	December 4
Ploughs, Steam	Wm. H. H. Miller	Littleton, N. H.	December 11
Ploughs	Oliver Sparks	Shelbina, Mo	December 11
Planters, Corn	Sam'l Mowry and Eli Deppen.	Womelsdorf, Pa.	December 11
Planters, Corn	A. S. and Daniel Markham	Monmouth, Ill	December 11
Planters, Corn	Samuel W. Adams	———, Moultrie co., Ill.	December 11
Ploughs	H. H. Baker	New Market, N. J.	December 11
Ploughs, Steam	John Reynolds	New York, N. Y	December 18
Ploughs, Gang	Jacob Haege	Shiloh, Ill	December 18
Planters, Cotton-seed	Richard C. Nash	Somerville, Tenn.	December 18
Ploughs, Mole of Drain	John Lane	Lockport, Ill	January 10
Ploughs, Mole	Elias Parrish and Watson Parrish, jr.	Galesburg, Ill	February 21
Ploughs, Mole	Samuel Adams	Toulon, Ill	February 28
Ploughs, Mole	Geo. L. Griffin & J. H. Carper.	Dallas City, Ill	February 28
Ploughs, Mole, Truck for	A. L. O. Wall, G. Roberts and M. S. Carter.	Decator, Ill	March 20
Ploughs, Drain	Jesse Hanon, jr.	Taylorville, Ill	March 27

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Plough, Mole	James Adair	Mendota, Ill	March 27
Plough, Mole	A. L. O. Wall, G. Roberts and M. S. Carter.	Decatur, Ill	April 3
Ploughs, Mole	A. Hammond	Jacksonville, Ill	April 10
Ploughs, Mole for Drain	A. B. Hawkins and John Puntenny.	Camden, Ill	June 12
Ploughs, Mole	C. W. Stafford	Burlington, Iowa	July 17
Ploughs, Mole	A. M. Karr	Mt. Pleasant, Iowa	July 24
Plough, Ditching	James Brooks	Romulus, N. Y	July 31
Ploughs, Mole, Adjustable mole for	Lathrop Kazar	Leroy, Ind	August 14
Ploughs, Mole, Portable capstan for	A. L. O. Wall, G. Roberts and M. L. Carter.	Decatur, Ill	September 11
Ploughs, Mole	H. Bagley	Tipton, Iowa	September 18
Ploughs, Mole	W. B. Atkinson	Plymouth, Ill	September 18
Ploughs, Mole	Owen Sturdevant, assignor to self and J. S. Gregory.	Maquon, Ill	November 13
Ploughs, Mole	John H. Elward	Ottawa, Ill	November 13
Presses, Cotton	James T. Ham	Sinatobia, Miss	January 10
Presses, Hay	Wm. McCord	Sing Sing, N. Y	January 24
Presses, Hay	John H. Gove	San Francisco, Cal	March 6
Presses, Cotton and Hay	J. W. Conway	Franklin, Ind	March 13
Presses, Cotton	Thomas H. McCray	Moscow, Tenn	March 13
Presses, Hay and Cotton	David L. Miller	Madison, N. J	March 20
Presses, Cheese	Myron E. Taft	Potsdam, N. Y	April 10
Presses, Cane	Eugene Powell	Conneautville, Pa	April 10
Presses, Tobacco	Edwin S. Collins	Aspinwall, Va	April 17
Presses, Cotton	Young F. Wright	Green Hill, Ga	May 1
Presses, Cotton	M. M. Jones	Morrisville, N. Y	May 15
Presses, Tobacco	Thomas N. Read	Aspinwall, Va	May 22
Packing flour, Machines for	Solon A. Clapp	Hamilton, Ill	June 5
Presses, Cotton	George Milleran	Byhalia, Miss	June 5
Press, Tobacco	John Sweaney	Chicago, Ill	June 26
Presses, Hay	Ithiel S. Arnold	South Milan, Ind	July 3
Presses, Hay	Silas G. Randall	New Britain, Conn	July 17
Presses, Cotton	Henry Mason	Lancaster, Mass	July 24
Press, Cotton and Hay	Horatio F. Hicks, assignor to Hicks Brothers.	Grand View, Ind	July 24
Pressing tobacco	John Henry	Lynchburg, Va	July 24
Press, Hay	Sylvester Stevens	Sacramento, Cal	July 24
Press, Cotton	Pickens B. Wever	Scarborough, Ga	August 21
Presses, Cotton	J. C. Sellers	Woodville, Miss	August 28
Presses, Cotton	Perry G. Gardiner	New York, N. Y	September 4
Pressing cheese	William McAllister	Gerry, N. Y	September 4
Press, Cotton	W. T. Opie	Scarborough, Ga	September 4
Presses, Wine	Wm. S. Kimball	Rochester, N. Y	September 4
Pressing tobacco, Machine for straightening and	Wm. W. Justis	Genito, Va	September 11
Press, Cotton	Rhodom M. Brooks	Meriwether county, Ga.	October 2
Press, Cotton	Robert Scott, jr	Madison, Ind	October 9
Press, Cotton	Solon Dike	Columbia, S. C	October 16
Presses, Cotton	Perry G. Gardiner	New York, N. Y	October 23
Presses, Cotton	Murdock Murchison	Denmark, Tenn	October 23
Polishing rice, Machine for	Daniel Lombard	Boston, Mass	September 4
Rakes, Horse	R. Lounsbury and F. G. Willson	Fulton, prov. of Canada.	January 31

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Reaping and mowing machines, Combined.	Thomas H. Dodge	Washington, D. C	January 31
Rakes, Horse hay	Henry Eastman, assignor to D. Henderson.	Indianapolis, Ind	March 6
Rakes, Horse hay	A. B. Johnson	Washington, Ind	March 6
Reaping and mowing machines	F. T. Lomont and John Grojean	Massillon, Ohio	March 27
Rakes, Horse	Lorenzo Beach	Montrose, Pa	April 10
Roots, Houses for preserving	Thacker V. Bush	Gallatin, Tenn	June 5
Reaping and mowing, Machines for	Daniel Sheats, Samuel H. Dubois and John B. Pressy.	Siusin City, Cal	June 19
Rakes, Horse	F. Seidle and S. Eberly	Mechanicsburg, Pa	July 3
Rakes, Horse	Wm. & Thos. Schnebly	Hackensack, N. J	July 10
Rakes, Horse hay	A. R. Hurst	Chambersburg, Pa	July 10
Reaping and mowing machines	Elizabeth M. Smith	Burlington, N. J	August 7
Reaping and mowing machines	Andrew A. Henderson	U. S. N	August 14
Reaping and raking grain and mowing grass.	Andrew A. Henderson	U. S. N	August 14
Rakes, Horse	G. S. Kinsey	Reading, Pa	August 28
Rakes, Horse	J. C. Stoddard	Worcester, Mass	September 11
Rakes, Horse	Daniel Strock	Chambersburg, Pa	September 11
Roller and Manure-spreader, Combined.	John Lyker, assignor to self and J. I. Brown.	Argosville, N. Y	September 25
Rakes, Hay	Cyrus J. Fay	Hammonton, N. J	September 25
Reaping-machines, Implements for	W. S. Stetson	Baltimore, Md	September 25
Rakes, Hay	S. J. Homan	Walden, N. Y	October 2
Reapers and Mowers	George A. Stephenson	Paw Paw, Mich	October 2
Reaping and mowing machines	McClintock Young, jr	Frederick, Md	October 2
Raking and pitching hay, machines for	A. J. Preston	East Guilford, N. Y	October 16
Rakes, Horse	John Chapell	Green, N. Y	November 20
Rakes for reaping-machines	Jacob R. Byler, assignor to self and Hugh W. Black.	Salisbury, Pa	November 27
Rakes for reaping-machines	Jacob R. Byler, assignor to self and Hugh W. Black.	Salisbury, Pa	December 4
Straw-cutters	N. Homes	Laona, N. Y	January 3
Seeding-machines	George B. Markham	Mead's Mills, Mich	January 3
Seeding-machines	John W. Hudson	Lafayette, Ind	January 10
Sap-conductors	Eli Mosher	Flushing, Mich	January 17
Straw-cutters	Ives W. McGaffrey	Buffalo, N. Y	January 31
Seeding-machines	Aaron Ring	Westbrook, Me	February 14
Straw-cutters	D. J. Powers	Madison, Wis	February 14
Seeding-machines	George Copeland	Gray, Me	February 28
Seeding-machines	A. R. Root	Canton, Mo	February 28
Seeding-machines, Centrifugal	John R. Rogers	Sacramento, Wis	March 6
Seeding machines	Worden P. Penn	Belleville, Ill	March 6
Straw-cutters	David Utley, 2d and Pell Teed	Leicester, N. Y	March 13
Seeding-machines	Edward B. Weakly	Pana, Ill	March 27
Seeding-machines	A. S. Notestein, assignor to self and L. J. Rogers.	Salem, Mass	March 27
Seeding-machines	A. B. Hutchins	Quincy, Florida	March 27
Sowing-machines	Wilson W. Williams	Elizabeth City, N. C	April 3
Seeding-machines	Alex. & Robert B. McElroy, assig'r to Robt. B. McElroy.	Waupun, Wis	April 3
Seeding-machines	James F. Gyles	Gilmer Township, Ill	April
Straw-cutter	C. B. Mallory	Fredonia, N. Y	April 3

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Seeding-machines	Alonzo R. Root	Canton, Mo	April 3
Seeding-machines	Thomas Lindsey, assignor to self and J. H. Beidler.	Lincoln, Ill	April 10
Seeding-machines	F. Chamberlin	Berlin, Wis	April 10
Straw-cutters	H. S. Root and Thos. Lloyd	Muncy, Pa	April 17
Seeding-machines, Broadcast	John Barnes	Lima, N. Y	April 24
Straw-cutters	N. Edwards and Edw'd G. Day.	Nassau, N. Y	May 1
Seeding-machines	J. B. Turner	Jacksonville, Ill	May 8
Seeding-machines	William J. Baker	Dimock, Pa	May 8
Sowing fertilizers, Machines for	Robert J. Hill	Americus, Ga	May 8
Seeding-machines	David Eldred	Monmouth, Ill	May 22
Seeding-machines	A. E. Doty	North Henderson, Ill	May 22
Seeding-machines	A. Kirlin	New Boston, Ill	May 22
Seeding-machines	Solomon T. Holly	Rockford, Ill	May 29
Soil, Machine for breaking and pulverizing the	Richard J. Gatling	Indianapolis, Ind	May 29
Seeding-machines	Matthew Mitchell	Altona, Ill	June 5
Seeding-machines	Mahlon B. Rupp	McVeytown, Pa	June 19
Seeding-machines	William Workman	Ripon, Wis	June 26
Seeding-machines	Thomas Wilson	Winterset, Iowa	June 26
Seeding-machines	D. W. M. Lower	Albin, Iowa	June 26
Seeding-machines	Joseph Sutter	New York, N. Y	June 26
Seeding-machines	Ezra Emmert	Franklin Grove, Ill	July 10
Seeding-machines	George W. Clark	Mt. Washington, Ohio	July 10
Seeding-machines	John S. Gage	Dowagiac, Mich	July 10
Seeding-machines	Edwin Ritson	Sanbornton Bridge, N. H.	July 10
Seeding-machines	Worden P. Penn	Belleville, Ill	July 17
Seeding-machines	Hermann Kaller	Perry, Ill	July 17
Straw-cutters	Samuel Ring	Cleveland, Ohio	July 24
Straw and Stalk cutters	O. W. Priston and W. N. Farnham, ass'ors to themselves, Payne & Odotts.	Corning, N. Y	July 31
Seeding-machines	David J. Vail	Industry, Ill	July 31
Seeding-machines	William S. Sawyer	Gratiot, Ohio	August 7
Seeding-machines	A. McElroy and J. H. Kimble	Fox Lake, Wis	August 7
Straw-cutters	David B. Caldwell	Cincinnati, Ohio	August 7
Scythe-fasteners	Charles L. Barrett	New York, N. Y	August 14
Seeding-machines	James Alsop	Clinton, Ill	August 28
Seeding-machines	Martin H. Mansfield	Ashland, Ohio	August 28
Straw-cutters	E. D. Lady	Nashville, Tenn	August 28
Spading-machine	Stuart Gwynn	New York, N. Y	August 28
Stalk and Root cutters	Frederick Fidler	Batavia, N. Y	August 28
Seeding-machines	Edward Badlam	Ogdensburg, N. Y	August 28
Sowing-machines	W. D. Mason	Jarrott's Depot, Va	September 4
Straw-cutters, Feeders for	Daniel Fasy	Rowsburg, Ohio	September 4
Sap-conductors	Homer Hecox	Rutland, N. Y	September 4
Seeding-machines	A. R. Park	Columbia, Texas	September 4
Straw-cutters	William B. Kern	Middlebourne, Va	September 18
Sowing-machines	J. L. Garlington	Snapping Shoals, Ga	September 25
Seeding-machines	Benjamin Barnard	Farmington, Ohio	September 25
Seeding-machines	David Eldred	Monmouth, Ill	September 25
Seeding-machines	J. B. Duane	Schenectady, N. Y	October 2
Seeding-machines	William M. Garce	Cox, Ohio	October 9
Stalks, Machine for pulling and cutting	Henry Snyder	Dayton, Ohio	October 9

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Straw-cutters	John H. Lilly	Bardstown, Ky	October 16
Sowing-machines	R. Chapman	Darlington District, S. C.	October 16
Sowing-machines	D. C. Teller	Beaver Dam, Wis	October 16
Stalks, Machine for cutting	Michael E. Rudasil	Sherby, N. C	October 23
Straw-cutters	J. A. & G. W. Cowdery	North Middleton, &c., Ky.	October 30
Seeding-hoes	Zerah B. Brown	Simsbury, Conn	October 30
Straw-cutters	Jacob Scheiffelin, jr	Tioga, Pa	November 20
Seeding-machines	James Morrison	Clinton, Me	November 27
Seeding-machines	Smith R. Warner	London, Ohio	November 27
Seeding-machines	Fantley H. Naylor and A. Ward	Niles Township, Ind	December 4
Seeding-machines	Henry Bell	Clinton, Ill	December 11
Seeding-machines	J. V. H. Secor	New York, N. Y	December 11
Seeding-machines	D. & W. W. Beal	Lester, Iowa	December 11
Seeding-machines	Horace Crofoot	Tarboro', N. C	December 11
Straw, &c., Machines for cutting	Warren Gale, assignor to self and B. B. Belcher.	Chicopee Falls, Mass	December 18
Sugar-juices, Furnace for evaporating.	Eugene Duchamp	St. Martinsville, La	January 31
Saccharine-juices, Defecating and decolorizing.	Joseph C. Tucker	New York, N. Y	February 28
Sugar-juices, Apparatus for evaporating	Seth W. Eells	Mansfield, Ohio	April 10
Sugar-juices, Apparatus for evaporating	Charles Harvey	Richmond, Ind	May 8
Saccharine-juices, Apparatus for evaporating	A. C. Clemens	Crain Township, Ohio	May 22
Saccharine-juices, Apparatus for clarifying and evaporating	L. P. Harris	Mansfield, Ohio	May 29
Saccharine-juices, Apparatus for evaporating	W. H. Gelbert and H. O. Ames.	Bayou Goula, La	June 5
Sugar, Clarifying	Herman G. C. Paulsen	New York, N. Y	June 19
Sugar, Apparatus for draining	J. J. Unbehagen	Baton Rouge, La	July 10
Sugar, Refining	Herman G. C. Paulsen, assignor to Horatio N. Tryatt.	New York, N. Y	September 18
Sugar, Crystallizing, Tanks for	Charles E. Bertrand	New York, N. Y	December 18
Stumps, Machine for extracting	James C Daman	Hartford, Ky	March 6
Stump-extractor	Caleb Bates	Kingston, Mass	April 17
Stump-extractor	Luzon C. English, assignor to self and G. M. Angier.	Caton, N. Y	April 17
Stump-extractor	Albert Broughton, assignor to self and Alex. Lindsay.	Malone, N. Y	June 19
Stump-extractor	John Hamlyn	Bellevue, Mich	June 26
Stump-extractor	Nathan Parrish	Galesburg, Mich	June 26
Stalls, Horse, Fire-escape Attachment for	David S. Neal	Lynn, Mass	July 24
Stump-extractor	James B. Lyons	Milton, Conn	August 14
Stump-extractor	William and Daniel Kimmel	Cambridge City, Ind	August 14
Stables for horses, &c., Safety	William E. McIntire	Salem, Mass	September 18
Scales, Grain	Charles H. Hunter, assignor to self and Wm. Thornbury.	Indianapolis, Ind	May 8
Scales, Automatic grain	Albert Gummer	Indianapolis, Ind	April 3
Separators for Hominy-mills	John Donaldson	Rockfort, Ill	January 24
Separators, Grain	B. T. Trimmer	Rochester, N. Y	February 14
Separators, Grain	L. B. Corbin	Dryden, N. Y	February 28
Separators, Grain	Jacob Schaeffer	Henderson, Ky	April 10
Separators, Grain	George Westinghouse	Schenectady, N. Y	April 17
Separators, Flour	Stephen Hughes	Hamilton, Ohio	April 17

Agricultural inventions or discoveries for 1860—Continued.

Inventions or discoveries.	Inventors.	Residence.	Date of patent.
Separator, Grain	J. H. McGehee	Athens, Ala	April 17
Separator, Grain	James A. Vaughn	Cuyahoga Falls, Ohio	April 24
Smut-machine	Grant B. Turner	Cuyahoga, Ohio	May 1
Smut-machine	Samuel Favinger, assignor to self and Absalom Barned.	Philadelphia, Pa	July 17
Smut-machine	Henry W. Shipley	Mount Vernon, Ohio	September 12
Smut and scouring machine	James White	Cleveland, Ohio	September 25
Smut-machine	H. L. Pierce	Millport, N. Y	October 30
Smut-machine	Robert Thompson	East Davenport, Iowa	December 18
Smut-machine	Richard Mohler	Lancaster, Pa	July 24
Separators and cleaners, Grain	William M. Arnall	Sperryville, Va	May 1
Starch, Construction of Machinery for cleaning.	Charles S. Irwin	Madison, Ind	May 15
Separators, Grain	W. T. McGahey & H. C. Foote.	McGaheysville, &c., Va.	June 12
Separators, Grain	George Arrowsmith	Lockport, N. Y	July 10
Separators, Grain	John C. Gregg	Hillsboro', Ohio	July 17
Separators, Grain, Governor attachment for	Lorenzo D. Lane	Freeport, Ill	July 17
Separators, Grain	N. A. Patterson	Kingston, Tenn	August 28
Separators, Grain	S. M. Wirts	Hudson, Mich	September 11
Separators, Grain	Moses Bugher	New Philadelphia, Ohio.	September 18
Separating and scouring grain, &c., Machine for	David S. Mackey	Batavia, N. Y	September 18
Separating grain, &c., Sieves for	H. W. Putney, assignor to self and Cyrus C. Crane.	Lyons, N. Y	September 25
Separators, Grain	Geo. Landers & H. Lampman.	Afton, N. Y	October 16
Separators, Grain	S. and O. Pettibone	Corunna, Mich	November 20
Separators, Grain	Charles B. Hutching	Rochester, N. Y	November 20
Separators, Grain	F. W. Robinson	Richmond, Ind	December 18
Sugar-cane leaf stripper	Philo P. Mills	Washington, Ohio	December 18
Threshing-machines	David S. Wagener	Penn Yan, N. Y	May 1
Threshing-machines	S. E. Oviatt	Richfield, Ohio	July 10
Trees from insects, Apparatus for protecting	Nathaniel Potter, jr	South Dartmouth, Mass.	July 10
Threshing peas & beans, Machine for.	James T. Smith	Portsmouth, Va	July 24
Threshing-machines	Wm. W. Dingee	York, Pa	July 24
Tree-protector	W. W. Taylor	South Dartmouth, Mass.	August 21
Trees, Instrument for	David P. Chamberlin	Hudson, Mich	August 21
Threshing-machines	A. B. Crawford	Piqua, Ohio	September 4
Threshing-machines	David Barger	Columbia, N. Y	September 11
Threshing-machine, Spike for	Albert B. Colton	Athens, Ga	November 6
Trees, Device for sustaining	Wm. H. Livingston	New York, N. Y	November 6
Treatment of Fibrous plants	Stephen M. Allen	Niagara Falls, N. Y	March 30
Ties, Iron, for Cotton bales	C. W. Wailey	Lexington, Ky	March 20
Tobacco screws	N. Hoag and Wm. H. Tappey.	Petersburg, Va	March 27
Windrowing sugar-cane, Machines for.	Benjamin A. Jenkins	White Water, Wis.	July 3
Winnowing-machines, Grain	John Bean and Benj. Wright.	Hudson, Mich	July 24
Winnowing-machines	Frederick H. Manny	Rockford, Ill	October 9
Wool, Facilitating the removal of burrs from	Charles L. Harding	Winooski Falls, Vt	May 29
Wool, Machinery for burring	E. J. McCarty	New York, N. Y	January 10
Winnowers, Grain	Henry H. Beach	Philadelphia, Pa	January 10
Weighing Grain, Machine for	John Williams	Kalamazoo, Mich	April 10
Weighing machine, Automatic grain.	Lovett Eames	Kalamazoo, N. Y	May 15
Weighing & bagging grain, Machine for.	James M. Fish	Buffalo, N. Y	June 5
Weighing-machine, Grain	D. Squier, jr., & E. A. Preston.	Battle Creek, Mich	October 16
Weighing-machine, Grain	James B. Mohler	Pekin, Ill	October 23
Yoke-fastenings, Ox	William N. Lockwood	New Britain, Conn	May 22
Yokes, Ox, Fastening pins in bows of.	J. Warner and T. C. Silliman.	Chester, Conn	July 17

GOOSEBERRIES.

FROM MAYALL BEAUMONT, CORRESPONDING SECRETARY OF THE HORTICULTURAL ASSOCIATION OF PATERSON, N. J., JULY 16, 1860.

By extraordinary perseverance the Horticultural Association of Paterson, New Jersey, have made great improvement in growing and maturing the gooseberry. This delicious fruit had previously been subject to many peculiar diseases, the most destructive of which was the mildew, and a decrepid appearance while growing, both of which have been effectually remedied by their ingenuity, skill, and labor.

In 1848 this Association held their first annual meeting, when the largest berry exhibited weighed a little over eight pennyweights. In 1849 the greater portion of their fruit was destroyed by mildew. In 1850 and '51 there was great difference of opinion, much discussion, and energy, and perseverance, resulting in the discovery of a partial remedy, the effect of which was visible in '51 and '52, when the largest berries weighed a little over ten pennyweights.

In 1852 Mr. John Ramsden imported a large number of plants from England, some of the best and latest varieties, of all the four colors, and in 1853 was able to distribute liberally plants and cuttings among the other members of the Association.

In 1854 and '55 their shows became highly interesting, the largest berry grown weighing upwards of sixteen pennyweights. High cultivation and experience in laying out the grounds had increased the weight of the berry over six pennyweights, and there has been no appearance of mildew since. The berries grown were all on imported plants; 1857 and '58 marked the same rate of progress. In 1858 Mr. Ramsden's *Teaser*, a beautiful yellow berry, weighed nineteen pennyweights, nine grains, being larger than any of the same kind grown in England the same year. In 1859 Mr. Henry Wilkinson's red berry (Speedwell) was grown twenty pennyweights, seven grains ; and July 16th, of that year, he produced one from the same plant twenty-two pennyweights, nine grains, being the largest of the kind grown, even in England, in the two previous years. It is thought that many years will not elapse before the gooseberry will be produced finer and larger in the United States than in any part of England.

Mr. Ramsden has in his nursery over one hundred different kinds of plants, besides innumerable seedlings and cuttings propagated from the imported plants and ready for cultivation.

There is some difference in the treatment of the various kinds of plants, even in the same nursery, but that is only when the greatest efforts are being made to ripen them for the days of exhibition, some being ripe and ready for plucking much sooner than others. The attention is most necessary in the fall of the year, both in propagation and whatever is essential to the preservation of the mother plant. The cuttings for propagation should be taken from the extreme ends of the branches; those from the middle of the plant, or the suckers from the roots, are of no value for such purpose.

The members of this Association, after the proper cutting of the mother plants, dig around them, from eighteen to twenty inches off from the stem, two feet deep, cutting away all the fibers or knotty stunted roots, and fill up with good soil mixed with a little coarse sand. It is then customary to manure well to protect the plants from the extreme cold during the winter.

Show at the house of Mr. George Porritt, Paterson, July 16.

Names of Exhibitors.	Names of Plants.	Weight.	
		Dwts.	*Grs.*
William Schoolcraft	Pilot (Maiden Prize)	15	08
James Cocker	(Maiden Prize)	15	07
Henry Wilkinson	Speedwell (P. P.)	22	09
James Cocker, sen	Conquering Hero	20	05
Isaac Cocker	Pilot	20	22
George Porritt	Paterson, (seedling)	13	07
Henry Isherwood	Flora	14	00
	RED BERRIES.		
Henry Wilkinson	Speedwell	21	09
Isaac Cocker	Conquering Hero	18	10
George Porritt	Passaic, (seedling)	18	06
James Cocker	Useful	17	10
Henry Wilkinson	Slaughterman	16	15
John Fairclough	Lion	16	00
" "	Companion	15	22
George Porritt	Maiden	15	08
	YELLOW BERRIES.		
Isaac Cocker	Pilot	19	22
" "	Leveller	19	16
George Porritt	Railway	19	15
Isaac Cocker	Catherina	17	14
John Fairclough	Creeping Jane	16	00
James Cocker	Two to One	15	16
Benjamin Garside	Drill	14	20
George Porritt	Washington, (seedling)	13	15
	GREEN BERRIES.		
Isaac Cocker	Overall	19	12
" "	Turnout	18	20
" "	Thumper	18	02
John Fairclough	Wonderful	17	16
" "	Queen Victoria	16	10
" "	Scantling Green	13	22
George Porritt	Seedling	10	17
" "	General, (seedling)	19	00
	WHITE BERRIES.		
John Fairclough	White Lion	17	15
Isaac Cocker	London City	17	04
James Cocker	Cossack	16	14
Isaac Cocker	Garside's White	16	07
John Fairclough	Freedom	15	16
" "	Antagonist	15	09
Isaac Cocker	Eagle	15	04
Henry Wilkinson	Tallia	14	09

PHILIP VAN BUSSUM,
WILLIAM BROOKS,
THOMAS GREAVES,
Officers of the Association for the present year.

NATIVE GRAPES OF TEXAS.

FROM H. C. WILLIAMS, AYR HILL, VIRGINIA.

Having spent last year in the vicinity of Jefferson, Texas, I paid particular attention to the Native Grapes of that Region, and am able to give a more particular description than is to be found in my Report on the grapes of Arkansas and Texas. Last season there was a full crop of fruit on the vines—the only time it occurred during my visits to that country.

The summer was one of unusual drought, the range of the thermometer throughout the months of July and August being from 90° to 110°, which high temperature was doubtless as unfavorable to the grapes as it was to other vegetation.

They were forced to ripen prematurely, and the relative proportions of water, acids, and sugar, were doubtless not developed as they would have been in a more favorable season. In many places the fruit withered on the vines, but when the soil was light, loose, and deep, and of a sandy consistence, the grapes matured themselves, and I am able to make the following note of their qualities; it refers only to the three varieties, dried specimens of which I have left at the Patent Office:

No. 1 is a large black grape, covered with a fine white powder, ovate or flattened, bunches five inches long, densely packed. Some of the berries measured seven-eighths of an inch in diameter; skin thin, flavor sweet, sugary, tolerably juicy and destitute of foxy aroma.

Young wood, deep brown, covered with dense white down. The vine, in its growth and leafage, proves its alliance to the species *Vitis estivalis.* It may be remarked here that the seeds of the grapes of the upper Red river have been brought to this place, and it is conjectured that several species have hybridized with each other until a mongrel race has been produced, some individuals appearing in greater perfection than others, as the traits of different parents have been preserved.

In no other way can the great confusion in the form of the leaves, the difference in the vines, and the variation of the fruit be accounted for. All the vines of the summer varieties are healthy, vigorous growing plants, not great runners, often covering the low bushes when growing near them, though, when they have nothing on which they can extend themselves, they will take a bush form and stand erect.

This is caused by the young wood being killed back each winter to a matured bud, which forms a branch the following season to undergo the same course.

No. 2. This is a reddish grape, nearly as large as the preceding. Some of the berries measured three fourths of an inch in diameter. The bunches are four or five inches long, open, and sometimes inclined to branch, and rarely densely packed. Previous to maturity the berries are clear and transparent. The skin is very thin. It is more juicy than the preceding, and has a rich delicate sweetness. With proper cultivation, in a favorable season, it would by many be preferred, as a table grape, to the Catawba.

Some wine has been made from the two summer grapes. I regret to learn that a newspaper, containing a notice of wine so made, which I sent to the office, was not received. Having no experience in wine making, my opinions on the subject are not to be trusted; but I cannot omit the suggestion that if the above described grapes should not possess a sufficiency of the saccharine principle, the best mode of supplying it is to evaporate a portion of the unfermented juice to the consistency of molasses, and mix it with the wine. Sugar or glucose, from any other source than the grape, will never, in my opinion, form that chemical combination to make a wine that will keep or become popular.

The above two varieties were in my first collection.

No. 3 is called the *Fall grape.* It ripens in September and October, and will remain on the vines until the beginning of winter. It grows near the small streams, in a rich deep soil, and often rambles over the tops of large trees. It is wonderfully prolific, the bunches twelve to fourteen inches in length, open and loose, often branching. The berries are small, the largest being half an inch in diameter, dry, but very sweet, and on this account greatly esteemed for drying. Its wine would be rich and generous, and, as it ripens when the weather becomes cool, its first fermentation would not proceed too far. This variety is entitled to a trial in our Southern States.

H. C. WILLIAMS.

LIST OF SEEDS, ETC., PRESENTED.

1860.

Jan. 6.—Hubbard-Squash Seed and Cuttings of the Fox Grape from William Shirland, Penn Yan, New York.

10.—A bundle of Cuttings of Hartford Prolific Grape from E. G. Whiting, Hartford, Connecticut.

13.—A bundle of Grape Cuttings from John Butterfield, Bedford, Massachusetts.

13.—A bundle of Grape Cuttings from Hon. Mr. Wilder, Boston, Massachusetts.

16.—A bundle of Grape Cuttings from James R. Selman, Leeds, Massachusetts.

16.—Amber Boo or Amber-scented Rice, from the Caspian Sea, from J. P. Brown, acting United States Consul, Constantinople.

25.—A bundle of Jopling Grape Cuttings from James W. Jopling, Liberty, Virginia, by W. M. Burwell.

Feb. 8.—Two hundred Grape Cuttings from William Knupfer, East Hampton, Massachusetts.

10.—An eighth of a gill of seed of a flower from a sand bank in Missouri river, from Bela White, Kenosha, Nebraska Territory.

17.—A bundle of Grape Cuttings from some unknown person.

24.—Five varieties of Flower Seeds from Lieutenant Mechlin.

23.—Six varieties of Grape Cuttings, from Dr. S. J. Parker, Ithaca, New York.

23.—One paper of the seeds of the Century Plant, from Daniel A. Hill, Santa Barbara, California, per Alexander S. Taylor.

Mar. 2.—One box (about 100) of Patras Currant Grape Cuttings from William Chamberlain, Red Hook, New York.

6.—Eight Cuttings of Geusta Grape, Seedling, per W. F. Hale, United States Post Office.

7.—Twelve varieties of Grape Cuttings, from Robert Buchanan, Cincinnati, Ohio.

13.—One quarter of a gill of Seeds of Long Cone Pine, of San Antonio Missions, from Alexander S. Taylor, Monterey and Santa Barbara, California.

14.—Dried samples of Solidago Squarrosa, (Golden Root,) Eupatorium Perfoliatum, (Thoroughwort,) Artemisia, sp. (Aromatic herb,) from unknown.

21.—Samples (one of each) of fiber of the Jute Plant of India, and Australian Flax, from Dr. Horace Norton, Newark, New Jersey.

28.—Twenty-one samples of Field Agricultural Seeds, from Prussia, by the Minister of Agriculture, Berlin, Prussia.

29.—Seven varieties of Grape Roots, from Hungary, from John Kolber, 592 Broadway, New York.

Apr. 2.—A small box, containing about 30 Grape Cuttings, from the farm of Dr. B. P. Howell, per John Redfield, Gloucester, New Jersey.

5.—Two gills of Goundie Tobacco Seed, from G. H. Goundie, United States Consul, Zurich, Switzerland.

14.—Samples of Seeds from Japan, from Professor S. F. Baird, Smithsonian Institute.

19.—One thousand Cuttings from Hungary, purchased from John Kolber, New York.

19.—Four small boxes, containing about a gill each, of Cape Horn Green Shell Pumpkin, Two-Stem Pumpkin, Large California Pumpkin, and Large West Indian Pumpkin seed, from John Danforth, New London, Connecticut.

May 3.—Samples of the leaf of Tobacco grown in Southern Hanover, from Samuel Ricker, United States Consul General, Frankfort, Germany.

8.—Twenty papers of Australian Seeds, from W. C. Hampton, Mount Victory, Ohio.

8.—Two ears of Sweet Corn, from W. A. Bulkley, Williamstown, Massachusetts.

11.—A box of Scions, Cuttings, &c., from Rev. J. T. Barclay, Beirut, Syria.

15.—A gill of Borba Tobacco, from W. H. McGrath, United States Consul, Maranham, Brazil.

June 8.—Two gills of Carnation Seed, (Dianthus Caryophyllus,) from Henry Haas, Depauville, Jefferson county, New York.

July 6.—Small samples of Italian Barley, Tuscany Wheat, and Polish Wheat, from Aaron S. Barrowdale, Secretary Agricultural Society, Barrowdale, Guadaloupe county, Texas.

20.—Ninety-four cases and two barrels of Seeds and Cuttings, Wheat, &c., from Syria, from Rev. James T. Barclay, Beirut, Syria.

July 21.—Twenty-four kinds of Specimens of fine Gooseberries, from Philip Van Bussum and Mayall Beaumont, Paterson, New Jersey.

23.—Three cases of Seeds, &c., from Syria, from Rev. James T. Barclay.

26.—Two small papers of Capim d'Angola and Capim Gordura grass Seed, from Marine T. Chandler, Sapuccaia, Brazil, care of Maxwell, Wright & Co., Rio Janeiro.

Aug. 2.—Samples of Wheat, &c.—six kinds—from Theo. Specht, Fredericksburg, Texas.

9.—Samples of Seven-headed Wheat, Trigo de siete espiegas, from S. M Baird, Albuquerque, New Mexico.

13.—One paper each of Sweet German Turnip seed and Improved Strap-leaved Turnip seed, from Edward L. Coy, Mount Hebron, New York.

16.—One keg of California Grape Brandy and one box of Wines, &c., var: from Kohler, Frohling & Bauch; also one box of Grape Brandy, from Col. A. Haragathy, (per Geo. Fisher, 33 Montgomery Block, San Francisco, California.)

20.—A few heads (each) of Trigo Colorado or Red Wheat, Trigo Blanco or White Wheat, Bearded Wheat, from S. M. Baird, Albuquerque, New Mexico.

23.—A few seeds of Lemita, a little lemon, from S. M. Baird, Albuquerque, New Mexico.

28.—Seeds and sample of hedge plant, from George Walker, of Pensacola, Florida.

30.—Three samples with a few seed of a running Grass, from S. M. Baird, of Albuquerque, New Mexico.

31.—A small box of "perfected" Tomatoes, from C. Edwards Lester, of New York.

31.—One bottle of Catawba Wine, from John Jacobs, Columbus, Ohio.

Sep. 10.—One can of Jopling Grapes, from James W. Jopling, (per W. M. Burwell, of Liberty, Virginia.)

13.—Four boxes, containing fine samples of Apples grown in Bergen county, from Ph. Van Bussum and Mayall Beaumont, of Paterson, New Jersey.

26.—A gill of Goundie Tobacco seed, grown in the Palatinate, from G. H. Goundie, United States Consul, Zurich, Switzerland.

26.—Two gills of Tuscan Wheat, from Abraham Neff, postmaster, New Market, Virginia.

Oct. 1.—A few of each of the Cornus Florida, Arisderua triphyllum, Smilacina racemosa, Viburnum acerifolium, Podaphyllum peltatum, from O. W. Morris, of Washington Heights, New York.

5.—One-eighth of a gill of Wild Grass seed (luxuriant) from S. M. Baird, Albuquerque, New Mexico.

15.—One-half gill of Blue Stem Wheat, from S. Ransom, Amboy, Ohio.

17.—A few Cuttings (each) of fifteen varieties of Gooseberries from England, from M. Beaumont, Corresponding Secretary of Horticultural Association, Paterson, New Jersey.

18.—One quart of Minnesota Wheat, (yield various, from 80 to 84 bushels per acre,) deposited by W. C. Dodge, grown by Starr & Gaylord, Lake City, Minnesota.

19.—Samples of Grapes, including (so called) Oporto, from Charles Ketchum, Penn Yan, New York.

22.—Sixteen kinds of Varieties of Tree and other Seeds, from O. W. Morris, Institution of Deaf and Dumb, Washington Heights, New York.

24.—Three varieties of Grapes: 1, perennial, hardy; 2, coarse; 3, annual, good, from New Mexico, from S. M. Baird, Albuquerque, New Mexico.

26.—Pods and seeds of an Ornamental tree from Mexico, from Arthur G. Rose, of Charleston, South Carolina.

26. Cuttings of Yuca brought from South America by H. S. Sanford, of Derby, Connecticut.

29.—Acorns of eight varieties of Oak, from W. C. Hampton, of Mount Victory, Ohio.

29.—A few Seeds of an Asiatic Muskmelon, from S. Lindsley, of Crescent Village, Texas.

Nov. 1.—A few flower Seeds, from Edward Wilson, of Sydenham, England.

5.—One-quarter of a gill of seeds of Lever wood (Carpinus Ostua,) from F. Odell, Shelburne, New Hampshire.

7.—Seeds of Virgilia lutea, from H. P. Byram, editor of the Valley Farmer, Louisville, Kentucky.

15.—Eight packages of Australian seeds, from W. C. Hampton, of Mount Victory, Ohio.

16.—Cuttings of North Carolina Seedling Grape, called "Mary Ann," from J. B. Garber, Columbia, Pennsylvania.

19.—A small bag of Sandwich Island Clover, one of Strawberry Watermelon, from Yucatan, and one of Chinese Potato Pumpkin, from T. N. Hornsby, Fisherville, Kentucky.

19.—Four quarts of Live-oak Acorns, from Solomon Cohen, postmaster, Savannah, Georgia.

23.—A portion of a Plant, (wild shrub,) with bloom and seed from some one unknown, from Newberry Court-House, South Carolina.

26 —California Pumpkin Seeds, from J. Danforth, New London, Connecticut.

Dec. 10.—Seventy-five varieties of American, European, and Australian tree seeds, from W. C. Hampton, Mount Victory, Ohio.

14.—Seed of a Wild flower called Chicoria, from S. M. Baird, from Albuquerque, New Mexico.

14.—Two gills of Okra seed, from W. H. Jones, of Raleigh, North Carolina.

18.—Package of Mountain Grape and Cratægus coccinea, from S. Vogel, of Smithson's Valley, Texas.

31.—About thirty roots of the Diebitch Grape vines of Silesia, from H. Kalusowski, of Washington city.

ERRATA.

Owing to the pressure of passing the proofs through the press, some errors have escaped notice till too late for correction in the text.

In the article on FERTILIZERS, the subject of SULPHUR, pp. 75–77, with the sentence "It will be seen," &c., to "straw and leaves," and also pp. 69–75, from "ASHES," to "unhesitatingly paid," should be inserted before the sentence "Thus much having been said," &c., on p. 52.

Other minor errors, easily seen, will be noted, and may be corrected by the reader without further mention.

N. B.—Several valuable articles prepared for this Report have been necessarily excluded in consequence of the limitation adopted after it was sent in to Congress. Some of these will probably be inserted in the Report for 1861.

INDEX.